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SENATE FACT FINDING COMMITTEE ON WATER RESOURCES

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Held In
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Sacramento, California

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October 31 and November 1, 1961

Subject: Reclamation of Waste Waters; Hearings

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A P P E A R A N C E S

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Senator Stephen P. Teale, Chairman
Senator John Murdy, Vice Chairman
Senator Waverly Jack Slattery
Senator J. Howard Williams
Senator Ed. C. Johnson
Senator Carl Christensen
Senator James Cobey
Senator Richard Richards
Senator Richard Dolwig

Lloyd Lapham, Executive Secretary
William J. O'Connell, Consultant

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TUESDAY, OCTOBER 31, 1961, 10:15 O'CLOCK, A.M.

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CHAIRMAN TEALE: Ladies and Gentlemen, I will now call the meeting to order. We still have some members to come in, but we can get over the opening part of this meeting. This is a meeting of the Senate Fact Finding Committee on Water Resources.

We have with us this morning on my far left Senator Jack Slattery from Mendocino and Lake Counties; Senator Ed. Johnson of Sutter and Yuba Counties; Senator J. Howard Williams of Tulare County; Senator Carl Christensen from Humboldt County; Senator John Murdy from Orange County; I am Senator Stephen Teale from Caliveras, Tuolumne and Mariposa Counties.

This committee for some months has been looking into means of adding to available water supplies in California, or of stretching existing supplies to meet increasing demands. Our last formal hearing was called to get reports from industrial concerns and governmental agencies on progress in methods of removing salts from sea water and brackish waters.

Those reports were encouraging. The cost of desalting water is going down, and the prospects are that this cost will continue to go down somewhat. Meanwhile, the cost of conserving and delivering water from natural sources is going up. And no one doubts that this cost will continue to go up.

Personally, I don't believe there is any question about the fact that we do need additional supplies of water, and I don't doubt but what we need to stretch present supplies. But in the reading matter available to the average citizen there seems to be a debate on the subject.

You can read scare stories on the one hand that say we are going to run out of water in the next week, or the next year, or the next decade. On the other hand you can read that such shortages as have occurred, or are likely to occur in the foreseeable future, are only local or transient.

The latest statement on the subject comes from an address to the National Reclamation Association by the Secretary of the Interior. The speech contained this paragraph, and this is a quotation:

"Unless ways are found to conserve more fresh water and to convert salt water cheaply into fresh, the United States only 20 years from now will lack enough water to meet its basic needs."

This is a reasonable statement. It agrees with my own conclusions on the situation. I think we can take Mr. Udall's word for this fairly imminent shortage.

Then, there is the often-quoted statement that California has enough water for all its ultimate needs if only the total outflow of streams in the state can be conserved and diverted for beneficial uses.

I think this statement overlooks the fact that the water doesn't always occur where it is needed, or overlooks the costs and other complications involved in transporting it. Beyond that, complete conservation of all our runoff just is not probable in our lifetime or that of our children.

Complete conservation would mean slack water in most of our major streams for most of each year. It would mean the most elaborate works to contain the flow of the two streams

draining the central valley. It probably would mean central control of the operation of all reservoirs, public or otherwise. In the meantime, we need to stretch or add to our presently available supplies.

This meeting was called to get reports on progress to the present, and potential in the future, of reclaiming industrial and municipal waste waters for a second use for beneficial purposes. We want to know about the amounts of water that may be reclaimed, about the processes involved, and about the uses to which reclaimed water can be put.

Let me make it clear that we are not proposing that our citizens should drink water contaminated by biological materials -- by human excreta, if you will. One of the purposes of this meeting is to consider whether present regulations for the protection of public health are adequate in the re-use of water.

Actually, the re-use of water is an old practice in California and for that matter in civilization. A recent book on water development contained this passage:

"The reclamation of sewage and waste waters is not as unconventional as it first appears because reclaimed waters have been used throughout the world for many years, primarily for irrigated agriculture. In 1953 reclaimed waste waters were used for irrigation at 106 places and for recharge of ground water at 112 places, all in California. There were also 118 places in the United States where such waters were used for industrial purposes."

One of the beautiful things about the re-use of waste

waters is that the waste usually is available in just the places where it can be put to use. Appropriately, the most extensive work done and planned in the field has been carried on in the Los Angeles area, and we will hear about that tomorrow.

Meanwhile, we will have some discussion of the pollution problems involved, and we have asked the Department of Water Resources for a general report on the subject.

I'll ask, first, Mr. Arthur J. Inerfield, Senior Engineer for the Department of Water Resources, to come forward. You may sit or you may stand, whichever you would like.

MR. INERFIELD: I am Arthur Inerfield, the Senior Engineer with the State Department of Water Resources and I am giving the statement for the Department. Before we start, there is an error on page 4 that I would like to correct. It is six lines down from the top where it says "(1) where other water is available", that should be "where no other water is available."

CHAIRMAN TEALE: Before you proceed, I would like to introduce Senator Richard Richards from the great County of Los Angeles.

SENATOR RICHARDS: Thank you.

CHAIRMAN TEALE: You may proceed.

MR. INERFIELD: This statement has been prepared to answer the questions posed in your memorandum of October 18, 1961, covering the subject of sewage and industrial waste reclamation. The questions are answered in order.

Question 1: What is your best estimate of the amount of waste water from municipal and industrial sources discharged annually in California?

Answer: At the present time, in California, it is estimated that approximately 1,600,000 acre-feet of municipal and industrial waste is discharged annually.

Question 2: What is the magnitude of use of municipal and industrial waste water in the State? What kinds of uses are there? What is the extent of conservation of waste water for possible future uses?

Answer: At the present time, it is estimated that about 110,000 acre-feet of waste water is put to direct use in the State annually. These uses are primarily for irrigation of crops, pasture, and lawn sprinkling. In addition, various lakes for which treated sewage provides the water supply are used for picnicking and fishing. At least one federal installation uses treated sewage for toilet flushing. While several industries are recycling their waste water, this activity is not considered as reclamation of waste water in the sense the term is used in this statement, as the recycled water has not been discharged as an industrial effluent.

In considering the extent of reclamation of waste water for possible future uses, we have made the assumption that water is reclaimed when it is allowed to percolate deliberately or incidentally into a ground water basin. Similarly, waste water is considered to be reclaimed when it is discharged to a stream, if a substantial portion of the streamflow below the point of discharge is utilized. For example, waste water from the City of Sacramento is reclaimed during summer months when the flow in the Sacramento River below Sacramento is diverted or used to repel sea water.

In addition to the estimated present annual direct use of 110,000 acre-feet of waste water per year, approximately 80,000 acre-feet per year is reclaimed by land disposal and subsequent percolation to underlying ground water basins, and about 120,000 acre-feet per year discharged to streams, of which an estimated 80,000 acre-feet is actually conserved. The following tabulation summarizes the quantities of wastes discharged, reclaimed, and lost.

Land disposal direct use is 110,000 acre-feet per year; reclaimed, 80,000; stream disposal reclaimed, 80,000; totaling 270,000 acre-feet a year reclaimed.

The quantity lost through stream disposal was 40,000 acre-feet per year and discharges to the ocean amounted to 1,290,000 for a total loss of 1,330,000 acre-feet.

Question 3: What additional amounts ideally would go into the ground water or into streams for eventual use?

Answer: The preceding tabulation shows an estimated quantity of 1,290,000 acre-feet of waste water being discharged to salt water annually. These discharges take place largely between San Francisco and the Mexican border. From preliminary considerations of quality, it is indicated that perhaps 40 to 50 percent of this amount might be reclaimed.

Question 4: How do the points of discharge match up with areas with demands for additional water supplies?

Answer: The attached map shows, and this is a map in the back of the statement. It is the last sheet. The attached map shows that the bulk of California's waste waters is discharged to salt water, and that most discharges occur in the

Southern California area. On a statewide basis, there is a good correlation between locations of discharges and areas of demand for additional water. Locally, however, discharges are concentrated at the end of the line, so to speak, while demands may occur anywhere in the watershed. This raises the question of the significant conveyance and distribution costs which may exceed the cost of treating the water for reclamation.

Question 5: What are the economics of the situation? To what extent is it worthwhile under present circumstances to increase the capacity of waste water reclamation facilities?

Answer: As in every study of water use, economics plays an important role. Careful economic analysis will, in many cases, mean the difference between reclaiming water and wasting it. In an economic analysis of waste water reclamation, the costs assigned should be limited to those in excess of the costs normally required for adequate treatment and disposal of the wastes in the basence of water reclamation. Items to be considered in the cost of reclaimed water include additional "polishing" treatment required solely for reclamation, additional storage, pumping, conveyance, and distribution.

In addition, it may be necessary to provide chlorination along the conveyance route to ensure that the reclaimed water can be delivered to its intended user without nuisance or other undesirable effects. Experience indicates that the following important factors must be considered in economic analysis of waste water reclamation: (1) Where no other water is available, waste water will be used to the maximum extent; (2) Where other water supplies are available, the use of reclaimed water is

dependent on the relative costs involved; and (3) People are willing to pay more for new water than they are for used water, even though the water qualities may be comparable.

It is very difficult to determine, in the absence of a marketing study, the willingness of water users to buy reclaimed water. In reference to the tabulation of reclamation water uses on page 14, you will see that no industrial use of reclaimed water is indicated. In spite of this record, we feel that there are industries, particularly in Southern California, that have an interest in using reclaimed waters. In this regard, the Department of Water Resources is currently preparing a report, entitled "Feasibility of Reclamation of Water from Sewage in the Los Angeles Metropolitan Area". Departmental studies basic to this report indicate a potential market for 116,000 acre-feet of reclaimed water annually wasting to the ocean from the Los Angeles Sewage Treatment Plant. Of this quantity, 45,000 acre-feet might be used by industries in Vernon and East Los Angeles, 17,000 acre-feet could be used in Torrance and El Segundo industrial areas, and the remaining 54,000 acre-feet could be used for ground water recharge in the West Coast Basin.

A realistic cost of reclamation of waste water should include the cost of conveyance and distribution to the areas of use. The cost, however, should not include the normal cost of treatment for disposal. The minimum cost for reclamation of sewage occurs where the sewage is suitable for use, say for irrigation, as it comes out of the sewage treatment plant and needs no further treatment. This situation occurs in many parts of the San Joaquin Valley where sewage treatment plant effluent

is used directly for irrigation, and the only cost involved in reclaiming the sewage is the cost of conveyance.

The following tabulation shows probable ranges of costs per acre-foot applicable to waste water reclamation projects.

Secondary treatment where primary treatment would otherwise suffice	$ 5 to 40
Polishing treatment (sand filtration) of secondary effluent if required	5 to 7
Chlorination of secondary effluent	2 to 3
Storage, conveyance, and distribution	1 to 20
Spreading	2 to 6
Injection	2 to 6
Demineralization	60 to 80

Question 6: What legal problems are involved?

Answer: There are a number of legal problems which may be considered in connection with the reclamation and use of municipal and industrial waste water.

Probably the first logical question concerns the authority of the agency reclaiming and disposing of the water for its own use or for use by others, to engage in such activities. Generally those agencies having the power to store, develop, conserve, and distribute water to lands or inhabitants within their service area have no problem with respect to their power to reclaim and distribute municipal and industrial waste water within their area, assuming that the water is or can be made available to them. Some authorizing statutes specifically include the power to reclaim water or to dispose of reclaimed water, sewage effluent, or other waste water. Some statutes specifically

permit contracts between agencies with respect to reclamation or disposal of such water. No attempt is made here to survey and list all these statutes or to ascertain their adequacy.

The second logical question concerns the legal availability of the water for appropriation and use. This involves the question of water rights. If the water is still under the control of the original appropriator there generally is no problem, providing the use is consistent with the limits of the water right and is within the powers of the agency. If the water passes beyond the control of the appropriator it then becomes unappropriated water available for appropriation and use by others. If it is introduced into the underground, all the legal questions with respect to control and use of ground water and of underground reservoirs come into play.

Some of the problems with respect to the use of ground water basins involve the question of the right to store water underground (declared by Water Code Section 1242 to be a beneficial use if the water so stored is thereafter applies to the beneficial purposes for which the appropriation for storage was made), the question of the right to draw down ground water basins in dry years and to replenish them in wet years, and the question of how the costs will be assessed or the benefits allocated.

Another problem involves the effect of reclamation and use of sewage and industrial wastes on the quality of the waters of the State, surface and underground. Generally, if an activity such as those under discussion results in a contamination or threat of contamination, as defined in Section 13005 of the Water Code and Section 5410 of the Health and Safety Code, the Depart-

ment of Public Health has jurisdiction and may act to abate the contamination. If such activity results in or threatens a pollution or nuisance, the water pollution control boards have jurisdiction and may prescribe requirements relative to the discharge (Divisiin 7 of the Water Code). If the reclaimed water is to be supplied to a user for domestic purposes, the supplier must have a permit from the State Board of Public Health under the provisions of the Pure Water Law (Health and Safety Code, Sections 4010-4035). If the water is to be injected into the underground, Section 4458 of the Health and Safety Code is applicable.

Question 7: What are the constituents of waste to be concerned with in reclamation? - Biological material, detergents, phenols, salts, etc.? What are the effects of these?

Answer: When considering the constituents of sewage and waste, it is safe to say that anything civilized society does not want ends up in the sewer. In general, the constituents of waste generally fall into several categories. These include suspended and dissolved mineral and organic matter, and dissolved gases. Domestic and certain industrial wastes contain biological material such as bacteria, viruses, and slimes. With the advent of the atomic age, radioactive materials also have appeared in sewage and waste discharges, and in the last 10 to 12 years synthetic detergents (ABS - Alkyl benzene sulfonate, the active agent in popular synthetic detergents for household use) have appeared in domestic wastes. All of these materials in some way have an effect on subsequent use of water. For instance, too high a concentration of dissolved salts makes

water unsuitable for most uses; too high a concentration of calcium or magnesium causes excessive hardness which is bad for domestic uses, boiler water, cooling, launderies, etc. Synthetic detergents in a drinking water supply cause foaming, unpleasant tastes, and undesirable esthetic effects. The level of radio-activity in a water used for recharging a ground water basin is of serious concern.

Since the time when water quality was first recognized as an important aspect of water use, various agencies concerned with the different uses of water have attempted to establish water quality criteria or standards. We now have accepted criteria which may serve as guides for public health aspects, for irrigation use, and for various industrial uses of water. Copies of these various criteria are appended to this statement. Although standards have been used for some time they are not static, and, as new developments and new research is completed, the limiting concentrations of constituents have had to be modified, or new constituents which had not been considered in the earlier criteria have had to be added.

Most states have adopted United States Public Health Service drinking water standards as criteria for judging the suitability of drinking water quality. However, the standards which were promulgated in 1946 have now become outmoded, and the Public Health Service has proposed a new set of standards which includes both changes and additions to the earlier criteria. New constituents include detergents, radio-activity, and chloro-form extractables, a measure of the organic matter which causes tastes or odors in water supplies. The Public Health Service

standards are concerned with limiting the constituents which are normally considered to be toxic; and, in addition, they recommend limits for total dissolved solids (which affect the potability of the water) and for iron and manganese (which cause stain and discoloration in domestic use) and for other constituents.

Problems of water quality criteria for industrial uses are very complex, since each industrial use has its own requirements which vary over wide ranges. A compilation of various industrial uses and the quality of water which is considered suitable for these uses is attached as page 21. It can be seen from this table that no simple set of criteria would apply for all industrial uses. The use of water for irrigation has its own special quality requirements. These criteria consider the effects of water quality constituents not only on the growing plant itself, but also upon the soils in which plants are grown. Constituents such as sodium tend to interfere with the percolation of waters through clay soils, whereas calcium and magnesium tend to make the soils more permeable. In addition, the irrigation water criteria are concerned with those constituents which are considered toxic to some plants. Boron is toxic to citrus and nut trees, and chlorides have a general toxic effect on most plants when the concentrations are high. The concentration of total solids in irrigation water determines the quantity of water which must be used to leach salts from the soils. In general, the higher the concentration of solids, the greater the quantity of water required to accomplish the necessary degree of leaching. In the use of waste waters for recharging ground

water basins, special consideration must be given to the concentration of radioactivity which may be found in the waste waters.

Question 8: Give a brief description of processes for removing these materials. What further research is needed in the field of removal of waste?

Answer: The quality of water, for the most part, reflects the characteristics of the mineral or organic constituents which may be either in suspension or solution. Removal of a substantial portion of the material in suspension is accomplished by primary treatment, a process which promotes sedimentation of the suspended material heavier than water and flotation for the greases, oils, and other materials which are lighter. Sludge removal and skimming disposes of the separated materials.

Even after sedimentation, however, a considerable portion of the organic matter, being colloidal or in solution, is not removed by primary treatment and remains in the waste water. This material requires for its removal further processing or, as it is commonly called, secondary treatment. Secondary treatment provides further stabilization, removal, or destruction of the organic matter by biologic means. The processes of secondary treatment ordinarily encountered are oxidation ponds, trickling filters, or activated sludge. Oxidation ponds are sometimes used in conjunction with the other processes. Where required, disinfection is accomplished by chlorine or the use of long-term storage in oxidation ponds. If polishing treatment is required, the effluent from a secondary treatment plant could be

passed through a sand or diatomaceous earth filter.

Most organic matter, such as human waste material, phenols, greases, soaps, etc., is substantially removed from wastes by the treatments described above, properly designed. Other organics, notably the ABS of synthetic household detergents, are incompletely removed from sewage by the above treatments and can be expected to be present in the effluents of normal secondary treatment plants to the extent of 2 to 5 parts per million.

Treatment to alter the mineral quality of waste waters is costly. At the present time, methods to reduce the salt concentration of waste waters are under study in various parts of the United States. The method getting considerable attention is the electrodialysis method, which uses charged membranes to reduce salt concentrations. A problem associated with demineralizing waste waters by the electrodialysis method is that the organic constituents are probably not removed. In using boiling or freezing methods of demineralization, the effects of organic waste constituents are uncertain.

Because of the technical difficulties and costs involved in altering the mineral quality of water, it can be assumed that, for the present, treatment of water for reclamation will be concerned with one or more of the following: (1) disinfection to prevent odors and health hazards, (2) sedimentation and flotation or sand filtration to remove solids and greases and to prevent unsightliness, odors, or difficulties in recharge operations, (3) softening to reduce scaling in heating equipment or soap-consuming characteristics, and (4) secondary or higher

treatment to provide biologic stabilization in order to prevent unsightliness, odor nuisance, and health hazards.

The following research projects would be useful in the reclamation of waste waters. I might say, gentlemen, that some of these studies are going on now but this is purely a listing of the ones which would be helpful. The following research projects would be useful in the reclamation of waste waters: (1) a study to determine when, in the cycle of natural and artificial purification, sewage and industrial wastes become water, (2) development of economical methods of removing ABS and other synthetic detergents from waste water, (3) development of methods for detecting synthetic detergents other than ABS, (4) a study of the viability of viruses in treated domestic sewage as it may effect reclamation and reuse projects, (5) development of economical methods for removing dissolved salts from waste waters, (6) development of economical methods of removal and disposal of radioactive substances, (7) restudy of criteria governing the suitability of water for reuse and reclamation, (8) study of the short- and long-term effects of irrigation drainage waters containing weedicides and pesticide residues on water quality, (9) study of behavior and fate of organic constituents in waste waters passing through the soil, and (10) a study to determine the marketability of reclaimed water for industrial use.

Question 9: Would you suggest any state action by the Legislature or otherwise to give further incentive to waste reclamation development?

Answer: The Department of Water Resources is not

prepared at this time to recommend definite action on the part of the State or Legislature to provide incentive to reclaim water. However, incentives might be offered in the following areas:

1. In the area of rapid writeoff for tax purpose where capital costs have been incurred by private entities to reclaim water.

2. In the area of water rights where use of reclaimed water as a substitute for surface or ground water does not prejudice rights to the surface or ground water.

3. Standardization of quality criteria against which to evaluate the suitability of reclaimed water for use.

CHAIRMAN TEALE: Thank you very much, Mr. Inerfield. I'm sure the committee appreciates the effort and time that went into the preparation of this report to us, and to me it seems that this is a very comprehensive and complete report that has had a lot of work put into it by someone, and I suspect that you probably were the one who at least had the responsibility for doing this work. I'm sure that there are probably some questions on the part of the committee. Senator Christensen.

SENATOR CHRISTENSEN: Mr. Inerfield, is the Department itself undertaking any experiments in connection with reclamation of these waste waters?

MR. INERFIELD: The Department itself has a sewage reclamation program. The reclamation program is involved in learning where the wastes are, measuring the strength of the wastes, determining what the mineral characteristics are, keeping abreast of the volumes which are being disposed of, and being in contact with those places which now use waste water for

reclamation. We also have monitoring programs where we try to monitor ground water in the vicinity of large waste discharges to find out what the effects are. There are lots of activities that the Department is involved in that try to determine in one way or another what the effect is of these waste discharges on the water resources. We have surface monitoring programs in which we have been trying to look for detergents in surface water. We find them in the sewage discharges and we do find them in the rivers, and we sample the rivers downstream from these discharges to look into these things.

SENATOR CHRISTENSEN: You have referred to a number of research projects which would be useful in the reclamation of waste waters. Has the Department undertaken any steps toward the use of or to engage in those research projects?

MR. INERFIELD: The Department itself hasn't engaged in any research projects as such. However, this type of research is being done in the State. The State Water Pollution Control Board for a number of years has contracted with the University of California, the University of Southern California, to look specifically into the use of reclamation. There are any number of reports that cover this activity. It is very comprehensive, and I might say that in the current year the State Water Pollution Control Board is endeavoring to study the effects of a waste reclamation program that is going into effect in the Whittier Narrows area.

I notice there are people here from Los Angeles County Sanitation Districts and I didn't want to steal their thunder, but the State Water Pollution Control Board is going to study

the effect of these wastes and we as a Department are helping. We are trying to assist in whatever way we can to make the information meaningful and helpful.

SENATOR CHRISTENSEN: Do you think that the Department is adequately financed to perhaps enlarge their activities in this field, or whether it needs any assistance?

MR. INERFIELD: I think I have to give you my personal opinion on this. I think that it is necessary with the large volume of wastes that are discharged in the State each year, I think that we have to look into all aspects of use. We have to look into the matter of criteria, and I think that the State Department of Water Resources has to make its contribution. In other words, we have to collaborate with the other agencies in this field to study this area. Now, how intensive, in other words, how much work should be done in any one particular year to be able to come up with an idea of financing, I can't tell you right this minute.

CHAIRMAN TEALE: Let me ask a question along that same line. Do you think the Department of Water Resources is the proper agency to be conducting research projects along this line, or do you think this should be left to the specialty groups such as the University and research organizations?

MR. INERFIELD: I think that there are some aspects of the research into this problem which can very well be done by the universities and have been, but I think there are some areas that the Department of Water Resources has a real contribution to make in areas where we have information about discharges now taking place, using our knowledge of flow of ground water and ground

water resources. There is a tremendous amount of background information has to be collected in order to be able to use this, and if the University wants to get this they have got to come to the Department of Water Resources, and the Department of Water Resources has to get this stuff together and make it available to them.

I believe there is a contribution that the Department of Water Resources has to make plus its over-all interest in any water as a source of supply.

SENATOR CHRISTENSEN: Do you believe the Department in view of the fact it has certain duties to perform by reason of the Porter Act and Feather River Project is subordinating its activities in this field of reclamation to those other projects which are a primary concern in the Department?

MR. INERFIELD: I don't think so, no, sir.

SENATOR CHRISTENSEN: Would you mention which of the projects you referred to on page 12 are going on at the present time?

MR. INERFIELD: Oh, I might say that No. 2, development of economical methods of removing ABS and other synthetic detergents from waste water, this is being studied all over the United States. The Public Health Service is very interested in this kind of thing, and this type of study is being supported by federal funds. I might say that in Europe the Germans are studying this method. In fact, they are in the process of developing legislation now and I have a copy that I could give Mr. Lapham, a copy of the German law that pertains to detergents in water supplies. The English, as an example, are very much

involved in the study of detergents on not only how to get them out once they get in, but how to prevent them from getting into the waste waters altogether.

SENATOR CHRISTENSEN: In that particular connection, is the Department itself doing anything in that field in connection with the detergents?

MR. INERFIELD: Purely on the monitoring basis at the present time. However, in the current year we expect to be asked by the State Water Pollution Control Board to make a study of the fate of the detergents or the occurrence of detergents in ground waters in Southern California.

SENATOR CHRISTENSEN: When that request is made, will the Department be in a position to undertake to comply with that request?

MR. INERFIELD: We think we will be, yes, sir.

CHAIRMAN TEALE: Mr. O'Connell, did you have a question on this same line?

MR. O CONNELL: You mentioned the people that are doing extensive research in Germany and I think similar research is going on in England. You mentioned the work that is being done by the United States Public Health Service. Am I correct in believing that a very large portion of the work that has been done in the United States has been done under the direction and at the expense of the American Soap and Glycerin Producers Association?

MR. INERFIELD: In other words, the American Soap and Glycerin Producers Association have been very active. In fact, I think that this is the major industrial group or the major

activities from the industrial groups have come from this association. They have been involved in this at least in the 10 years that I have been aware of detergents, and this group has been very active. This is true.

MR. O CONNELL: That's what I wanted to bring out.

SENATOR DOLWIG: Referring to the second-to-the-last map, you have location of waste water reclamation projects. Can you just very generally tell us what these waste water reclamation projects are and what the Department is doing?

MR. INERFIELD: If you look at page 14, we have a list of all these places where sewage is used.

SENATOR DOLWIG: Do these dots represent all the areas that you have listed here and communities?

MR. INERFIELD: That is right. We were just trying to show where in the State of California sewage or waste is being used and that is the purpose of the map, but all these places that are listed on the map are also listed in the table.

SENATOR DOLWIG: Are there any projects which are under the jurisdiction of the Department? Is the Department doing any research? Do they have any jurisdiction insofar as any of these projects are concerned?

MR. INERFIELD: We have no responsibility. We have no legal responsibility with regard to this, but a lot of these areas we are monitoring. For instance, we monitor ground water below these plants. We maintain a familiarity with these plants and the people who are operating them to continually learn more about this matter of waste reclamation and the possible effect of waste reclamation.

SENATOR DOLWIG: Well, these projects, then, are not under the jurisdiction of the Department?

MR. INERFIELD: No, sir.

SENATOR DOLWIG: These are presently projects that are by local jurisdictions, and you are developing information from these projects, is this correct?

MR. INERFIELD: Yes, sir.

SENATOR DOLWIG: Thank you.

CHAIRMAN TEALE: Senator Richards, and then Senator Williams.

SENATOR RICHARDS: First, on the issue of administrative connection, if any, between the Department of Water Resources and the research work that you have described as being of interest to the Department and other branches of state government such as the State University, is there a direct link on those issues pertaining to water development, or in this case water purification or reclamation, or is it merely a matter of your receiving, for example, reports from the University the same way any of the rest of us might?

MR. INERFIELD: No, there is a direct link. The State Water Pollution Control Board organized a group called an interagency staff working group. On this group are representatives of the State Department of Water Resources, Department of Fish and Game, the Health Department and the State Water Pollution Control Boards. This group is charged by the State Water Pollution Control Group with studying all the proposals for research work. This is a committee to review research work that has been done by the contractors, that is,

the ones with whom the State Water Pollution Control Board has contracted. I can't say whether we are directly linked with every piece of research, but we certainly are with many of them.

SENATOR RICHARDS: Generally speaking, in this field one hand does know what the other hand is doing so far as the money, for example, the State puts up for the Department on the one side and for the University on the other. This is a matter of exchange so far as research is concerned?

MR. INERFIELD: Yes.

SENATOR RICHARDS: It would end up in the same benefit if obtained by either?

MR. INERFIELD: This is right.

SENATOR RICHARDS: Now, again to follow Senator Christensen's question, on page 12 there are 10 specific studies which have been delineated as at least of interest to the Department, one of which you mentioned, item No. 2, as being general research taking place all over the world, and of course, you are watching the results thereof. I assume that a number of others are likewise in being, are they not?

MR. INERFIELD: Yes, I think to a large extent practically all of these are in being in one place or another.

SENATOR RICHARDS: May I be specific, because it touches on two other places, where this was mentioned in the report, and that is the question of radioactivity. Who is undertaking the responsibility of ascertaining the highest level of radioactivity commensurate with public health or the dangers thereto?

MR. INERFIELD: I think Public Health. They are

charged with the responsibility of the public health aspects of radioactivity, and their monitoring programs, for instance, cover the health aspects of radioactivity.

SENATOR RICHARDS: Then, the determination of the level of tolerance of the human body to a certain level of radioactivity in the water, the standards, if any, will be developed by and are the responsibility of the Department of Public Health, as you understand it?

MR. INERFIELD: Yes. I'm probably not saying that exactly right and I would rather leave it to the Department of Public Health. Actually, the AEC has been primarily in this field of radioactivity. UnitedStates Public Health people have combined with the AEC to try to come up with some kind of standards. I understand now in some areas they don't agree.

SENATOR RICHARDS: That is one of the questions I had. Where do we go to find out, who is the final voice in this, if anyone, and secondly, once the standards are developed, as your statement implies here, the method of removal and disposal of radioactive substances, in other words, the question of purification of the water, is this within the realm of the Department itself?

MR. INERFIELD: I think this is within the realm of the Department. I think the Department has to make itself familiar and has to make itself knowledgeable about all of these aspects of alterations and changes of water quality. I think it has to not only because it is responsible to the State of California, but because of its own projects. In other words, you have to protect your own waters. Now, whether the Department

itself should engage with its own employees in the matter of detailed research, in my own mind there is a question. I think that we have to support this kind of research, but in my own opinion I don't know whether the Department should engage in the research with its own people.

SENATOR RICHARDS: Let me ask this, and then I'll drop this subject, but I wanted to pin it if I can on one practical question. Let's assume synthetically that within a given period of time there is suddenly a crisis concerning the degree of radioactivity in the atmosphere and in the water of a given area, that there is disagreement as far as local authority is concerned as to whether this is dangerous or not. Very obviously, who settles that disagreement? Is there someone now in the State Government ready, willing and able to take over and say, this is the level which is safe, or not? Item 2 here, what do you do in order to clean it up? Is there someone who can do that now?

MR. INERFIELD: I think the State Department -- this is my opinion, Senator, I think the State Department of Public Health is in a position to do this.

SENATOR RICHARDS: All right.

CHAIRMAN TEALE: I would like to call the attention of the committee to the fact that the Director of the Department is here and if you have have questions to direct in that line, he will be willing to come forward and answer.

SENATOR RICHARDS: I had another question. Shifting the subject entirely, the question of cost of distribution of water, on page 5, for example, you refer to the cost of

conveyance, and elsewhere in the report you point out, for example, on page 4, that the Los Angeles area is an example of water that is being wasted and could in large amounts be reclaimed. Now, has anyone endeavored to break down the costs of reclamation in the Los Angeles basin predicated upon this rather broad spread having to do with conveyance from $1 to $20, which is a big spread and of course doesn't enable us to come up with much of an answer.

MR. INERFIELD: Yes, studies have been made by the Los Angeles County Flood Control District and Los Angeles County Sanitation District.

SENATOR RICHARDS: So that other witnesses here would probably --

MR. INERFIELD: Other witnesses would be able to discuss this, yes.

SENATOR RICHARDS: And lastly, Mr. Chairman, you mentioned in the field of studies that there has yet not been determined other than by the one method of electrodialysis, which in itself has problems, as you point out, other methods that have been proved beneficial and economically feasible for the doing of this job of reclamation? Specifically, on page 11 the statement is made, "In using boiling or freezing methods of demineralization, the effects of organic waste constituents are uncertain." Is that because of lack of sufficient tests and so on or is it because there is just no method of demineralization which is practical using boiling or freezing?

MR. INERFIELD: I think that when we discuss the matter of reclamation of sewage by these methods, sewage has a

relatively low concentration of salts as opposed to sea water, so the methods which would be applicable to reclamation of sewage would generally be those that are concerned with brackish water reclamation, that is, where the total salt concentrations are low. Now, in these areas the method that shows a savings in cost because the total salt concentration is low is generally this dialysis method, and this is where you have plates and the water goes in one end and the concentration goes out and lesser concentrations go out, like in Coalinga. Coalinga has this method. So in general, when the reclamation of water from waste is studied, generally it is this dialysis method that is looked at. I don't recall anyplace where the reclamation by boiling or by distillation has been studied, but my professional judgment is that where the freezing or boiling methods would be looked at there would be a problem because there are certain constituents of waste which would boil over as an example, or when you freeze, and I know this from my own case as an example of just this. I thought that instead of having to buy distilled water for my iron at home I would take the frost on the inside of the refrigerator and use it, but I find that this material has picked up odors and all kinds of things and when I put this into my iron it was completely unfit for use and I had to clean out the iron. So what I'm saying is where you use sewage you have a problem with materials which you normally do not expect, organic substances, volatile matter and so on, and I don't think it is certain as to what happens when the demineralization process is applied to these.

CHAIRMAN TEALE: I hope the hospital doesn't find out

about this, but we clean our water up by boiling.

SENATOR WILLIAMS: Don't mention hospital to me. The question I have goes back prior to the time that you probably were working for the Department, but at least here is one question I think you may be familiar with. About four years ago, the committee visited this plant at Richmond where the University of California was treating sewage water and so forth, and we were told at that time, if I recall correctly, that they had reduced the sewage water down to where it could be used for domestic use, but the trouble was the cost made it excessive. Now, I'm going back a little further than that and prior to the time you were with the Department, the late 1920's or early 1930's when a firm by the name of Black and Veich who were chemical engineers of some sort took part of the outfall from the City of Burbank down near Los Angeles and reclaimed it for practically peanuts. Now, tell me something, has the University of California come any further, to your knowledge, in ascertaining the exact cost of getting this water down to where we could afford it, that is, getting it so it is fit for human consumption and not just for agricultural use, which is what most of us are using it for now. I'm thinking of Pomona and Porterville where they use it for irrigating cotton and that sort of thing and don't use it for domestic use. Do you know if anything has been done? As far as your Department is concerned, I'm sure nothing had been done.

MR. INERFIELD: We haven't engaged in this kind of activity.

SENATOR WILLIAMS: I wondered if you knew whether the

University has done anything.

MR. INERFIELD: The University is engaged in reclama- of water of all kinds. They have looked into solar heat to reclaim waters, they have looked into the matter of the use of algae to reclaim waters. I don't think that the University of California is ready to say that they have been able to produce a water reclaimed from waste that could be used for domestic purposes except perhaps the one where it has been distilled. In other words, I don't think that the University of California, and I have to guess at this, Senator, I don't think that they feel that they have been able to produce a water which can be directly used for drinking water. Of course, there has been some workdone on this particular case back East, I think in 1958 or so, when a community in Kansas ran out of water and they undertook to take the sewage effluent from their plant and bring it back upstream and put it into their water treatment plant, and these people did drink this sewage effluent directly. It was treated. They made an attempt to conform to the Public Health Service standards and the water was recycled as many as seven or eight times, but towards the end of the seventh or eighth cycle it began to look a pale yellow and had odors. It foamed when you took the water out of the faucet. It foamed like a head of beer and I noticed a comment made was the sale of bottled water went up in the community.

SENATOR WILLIAMS: That process was very expensive or was it tremendously expensive?

MR. INERFIELD: They actually used a conventional sewage treatment process for their normal waste disposal. The

effluent from this was put into their drinking water plant. They actually didn't provide -- I think they provided some storage, but they didn't do anything extraordinary. They didn't make any heroic efforts to do anything different than what they would have done ordinarily. There was another community, for instance, that did the same kind of thing, and where normally a city would disinfect their sewage or their drinking water with maybe one or two parts of chlorine, their community used 120 parts per million of chlorine, and they noticed that things came out of solution. The water deteriorated, it changed color and floc developed. I don't think we know enough about the quality of water to be able at this time to safely say that we can take water and treat it so that it can be used for domestic purposes without any danger.

SENATOR WILLIAMS: The thing that has been bothering me is that 30 years ago Black and Veich did all this and said it was a success. It was a success to a point where all of us went down and washed our hands and face in it and drank it, but yet now they can't do it. They say we don't know enough about it. What, I'm trying to find out from somebody, and I realize this is going back a long ways before most of the committee were born, why is it they could do it in the thirties and guarantee it as they said they could, and maybe they can't but they said they could, and yet here 30 years later we can't do anything because we don't have any information.

MR. INERFIELD: Senator, I would have to read their report and I would have to see their criteria. Everything is criteria. What did they attempt to do and how did they meet

these criteria?

SENATOR WILLIAMS: I can tell you what they attempted to do and what they actually did. They took part of the outfall, ran it into their plant and generated electricity and ran all their pumps and lights, and they extracted the solids, or at least I hope they did because we drank it. It looked like mountain spring water. It didn't taste bad. Well, that's something that certainly the Department might dig into if they have the time to find out whether this bunch knew anything or not.

You know we get a lot of ideas. The man who makes Dr. Ross' Dogfood came to me one day and said, "I've got the solution to the sea water conversion program." You know what I did with him? I shot him right over to the Department to let them talk to him. So we get lots of inquiries and we don't know the answers, not being men of professional ability like you and the other boys in the Department, so we have to pass it on to some of you fellows. That's all I have, Mr. Chairman.

CHAIRMAN TEALE: Senator Cobey.

SENATOR COBEY: Senator Williams, I want to thank you for that compliment. You make me almost young enough to be President.

Mr. Inerfield, I notice in your recount of the various forms of sewage treatment, I didn't see any mention of this method that I understand at least now is being used in the small plants, of compressed air injection which eliminates your sludge. As I understand, you don't even have a sludge residue under that system.

MR. INERFIELD: This activated sludge is the process that you are describing, Senator.

SENATOR COBEY: Is that the residues, then?

MR. INERFIELD: It is a modification of this. In the big plants there is a sludge and in smaller plants, a lot of it is destroyed.

SENATOR COBEY: Now, the second thing that I wondered whether you had any comment on, we are under the impression at least in the San Joaquin Valley that the State Department of Public Health much prefers that we put our effluent into the soil before we put it directly in any watercourse. They seem to have rather strong opinions on that matter. No matter what the type of treatment has been, they feel it is a little safer to put it back into the soil first rather than to discharge directly into any body of water. Do you have any comments on that, because that does affect rather directly the cost of the reuse.

MR. INERFIELD: I have to give you a professional opinion and I would say this, though, that when we talk in terms of sewage disposal into a stream, we are talking -- the biggest factor we are concerned with is the matter of disease transmission. Sewage is a vector of disease. Now, when we depend upon things like treatment facilities and we depend on disinfection by gas, machines as an example, anything can go wrong. A large volume of sewage will come down unexpectedly and your treatment does not any more provide the things it was supposed to do in the specifications. The chlorine gas machines are famous for, at least in the past, breaking down when you

needed them most, and if the Health Department talks about percolating this material onto soil before going into a stream, what they probably have in mind is a factor of safety which they know is necessary because in the past where you discharge directly into a stream this factor of safety may be absent.

SENATOR COBEY: You can't have any foolproof system where you set in enough standbys so if any part of the process fails due to human error or mechanical failure, automatically some standby goes into effect?

MR. INERFIELD: I would love to do this. Presumably, you can if you don't count money. When you get into economics you have another story altogether.

CHAIRMAN TEALE: Senator Dolwig, do you have a question?

SENATOR DOLWIG: I was just wondering if you would comment on the recent articles in the newspapers on the General Electric home appliance method now of using waste water for home consumption. This morning the newspapers have been carrying it and General Electric has indicated it is very successful.

MR. INERFIELD: I didn't see it, I'm sorry.

SENATOR DOLWIG: It is very interesting.

MR. INERFIELD: It is an intriguing possibility, but I don't know what the process is, I'm sorry.

SENATOR DOLWIG: You are not familiar with it at all. I just had one other question and that is on page 6, I was just wondering if you know what are the legal questions that would result with respect to the control of ground water and

underground reservoirs after water had passed beyond the control of the appropriator? Could you just tell us what some of the problems would be?

MR. INERFIELD: I would really like to call on our attorney. We have an attorney here.

MR. CARL: I'm not quite entirely certain of your question, Senator.

SENATOR DOLWIG: The statement here is if the water passes beyond the control of the appropriator and then becomes unappropriated water available for appropriation and use by others, then they go on and say if it is introduced into the underground all the legal questions come into play. What are the legal questions that come into play?

CHAIRMAN TEALE: Will you identify yourself for the record?

MR. CARL: I'm James Carl, Senior Attorney, Department of Water Resources. That statement admittedly is pretty general and was made that way on purpose because there are so many questions involved when you get into the problem of ground water reservoir regulation and control. Yet, to begin with, you have to go back to the law of water rights in California with respect to use of ground water. You have to consider the overlying rights, the rights of the overlying landowners to the use of the water in the basin. Their rights are correlative, quite similar to the riparian rights on a surface stream. Now, the ground water is, of course, subject to appropriation by others and it is available for appropriation if there is a surplus in the ground water basin or if the appropriation

exceeds the safe yield, then the overlying owners can file suit to enjoin the appropriation of water for transfer for use or the taking of water for uses other than the overlying uses. So that first of all you have to consider their rights to the ground water basin, the rights to the use of the water. If you inject the water, then the question is do you have the right to take it out again? Of course, you have that section in the Water Code that provides that that is a beneficial use of water and there have been some cases such as the Glendale case where water was put into the ground, underground, and taken out again for subsequent beneficial use for the City of Los Angeles. So you can use the ground water basin that way but we have not solved all the questions such as the questions involved where you want to draw down the basin during dry years and then fill it up again in wet years, and if you do that you are interfering with the rights of the overlying landowners.

SENATOR DOLWIG: The reason for my question was to determine whether we have enough precedent in the cases now to take care of this problem or, in your opinion, would further legislation insofar as water rights are concerned be necessary?

MR. CARL: I think that there is probably some additional legislation needed. I'm not prepared to say what it is. We have from time to time made some rather minor suggestions and we have also made suggestions that this does need to be studied and thought out and I don't know that I can say just what the final answer is.

SENATOR DOLWIG: Let me ask you then, in your Legal Department is there any research being done as to legislation

that could be recommended on this problem?

MR. CARL: I don't think at the present time we are engaged in that. We have recognized that there is a problem.

SENATOR DOLWIG: Well, there has been a problem in Los Angeles on this.

MR. CARL: I don't believe at the present time we have any project going where we are directed toward recommending specific legislation.

SENATOR DOLWIG: Thank you very much.

CHAIRMAN TEALE: While we have Mr. Carl here, is there anybody else wishes to ask a question of Mr. Carl? Senator Cobey.

SENATOR COBEY: Mr. Carl, your basic problems in connection with California ground water law are that the two basic concepts of its nature are actually out of date, aren't they, percolating water on the one hand which is not subject to appropriation under statutory procedure and your subterranean flow of the streams, and actually, the legal concept of percolating water is now out of line with your present scientific concept, isn't it? In other words, there is no such thing as unrelated flow of water underground which gave rise to the concept of percolating water back in the 1850's,as I recall?

MR. CARL: Well, we still have that as a legal concept and whether from an engineering standpoint that is true, I couldn't say, but we do still have that in the law as a legal concept.

SENATOR COBEY: Don't you think we better give a little thought to bringing the law into line so it is in line with the

present scientific information on basic concepts?

MR. CARL: I'm not certain that that is correct from an engineering standpoint. I would have to refer that to our ground water experts. I thougnt there still was percolating water but maybe I'm behind the times.

SENATOR COBEY: Well, I just didn't think there was any water that was unrelated to any other water source.

MR. CARL: It is not all flowing through known and definite streams, either.

CHAIRMAN TEALE: Are you water fellows through? Senator Murdy.

SENATOR MURDY: Mr. Inerfield, you used the expression "polished water" several times. Will you tell us what that means?

MR. INERFIELD: Sewage, generally speaking, has gone through the traditional primary treatment, secondary treatment, and now when the water comes out it isn't absolutely devoid of all material. There are still materials in it which for disposal into streams in many cases is probably okeh, but when you consider other kinds of disposal or other kinds of things, for instance, injecting into ground waters through a well of one kind or another, we find that a very high grade purity -- I'm going to use this term "purity" and what I really mean is the materials, the suspended materials must be almost completely removed. Otherwise the area around the well you are trying to inject into plug, so in general, secondary treatment, and this is the one where we use just biological stabilization after sedimentation, is probably not good enough for this kind of use,

so we have to do something else and the next thing you might do is to put it through a sand filter, perhaps, and get out the last or try to get out the last vestiges of suspended material that you can. I call this kind of thing polishing, the final touch.

SENATOR MURDY: Thank you.

SENATOR RICHARDS: I have a question. Also on the question of the terminology, just to understand it, on page 8 you refer to bacteria and viruses and slime. Now, the former, bacteria and viruses, have a specific definition. Is slime a term engineeringly used or a slang term?

MR. INERFIELD: No, the term is engineeringly used.

SENATOR RICHARDS: How is it defined?

MR. INERFIELD: I don't know if this is a bacteriological term, but it is certainly an engineering term. There are types of organisms which you associate with sewage disposal and we call them slime producers. They are incapsulated with materials that we normally call "slimy". I don't think it is a precise -- I'm not sure now if it is a precise bacteriological term, but it is used engineeringly.

SENATOR RICHARDS: It came up again, and the reason for my question was that taking your table on page 21, for those of us that are not engineers and do not understand it, for example, turbidity means one thing to me. I don't know what it may mean in terms of analyzing an available supply of water. The same way with the amount of iron, the amount of manganese and so forth. I understand the terms, but I don't know how to translate them into a layman's term of pure water versus

polluted water. Now, so that we may understand this table, is there one of these columns, or any one that makes a rough test in terms of -- for example, I see under "turbidity" that it takes a lower figure for carbonated beverages, a higher figure for beer. I see that you have a higher figure for manganese content and a lower figure for beer. Is there someplace here you can get a rough idea so as to make sense out of this entire table?

MR. INERFIELD: I tried, I guess unsuccessfully, then, to indicate that when we deal with industrial wastes there is no criteria that is universally applicable to all of these things and you raise a very good point on the matter of turbidity. Turbidity is really the capacity of a water to permit light to be transmitted through it. A very turbid water doesn't permit light to go through. A very clear, unturbid water permits light to go through. You have a carbonated beverage and that is one of its sales points, the clarity of the material, and you don't want to have any particular material in suspension. Beer would, being darker, presumably the criteria is not as precise and you could have, I wouldn't say a lot of turbidity, but you can probably stand more than a bottle of sparkling water, as an example. So you really have to look at the use that is being made and then you figure the economics. In other words, it always costs more to get the last bit out than it did the one before, so on all of these you have to make an economic analysis of how good do they want this to be, and it almost always comes up with a matter of cost.

CHAIRMAN TEALE: Senator Slattery.

CHAIRMAN SLATTERY: Mr. Inerfield, I gather from your answers to various questions with reference to the twelve projects which you have listed, research projects, that the Department does not enter into any of those, but you do have your fingers on the pulse of those?

MR. INERFIELD: Yes.

SENATOR SLATTERY: Is that a true statement?

MR. INERFIELD: This is research programs, yes, this is true.

SENATOR SLATTERY: Generally, the firmness of the grip on the pulse is pretty well shown by the amount of money spent. Would you be able to give us any idea as to how much is budgeted for this finger-on-the-pulse thing with research on reclamation of waste water?

MR. INERFIELD: No, Senator. The reason I say that is that one of my jobs -- I'm a water quality man, and one of my jobs is to keep an eye out to become familiar and be aware of what happens in the field of all of these areas and to disseminate this to the other people who work in the Department who have an interest in this, and I can't segregate this. In other words, there is no one, I can't segregate the costs, certainly in my case.

SENATOR SLATTERY: How, then, are we to know how serious the Department is about this? Now, you say you are serious, you are interested, you are not doing any research, but you think the problem is one of importance. Now, we would like to know, I would like to know, I'm trying to find some criteria to determine how important you think this problem is.

MR. INERFIELD: Okeh. We have in preparation right now what we call Bulletin 80, which is a feasibility of sewage and waste reclamation, Los Angeles County, which is about to come out with very definite recommendations of the possibility of reclamation down in the Los Angeles area. This is a very clear statement and when this report comes out I'm sure you will agree that we really recommend looking into this matter of waste water reclamation.

I point that out in my statement, one of the things we have uncovered in the course of making this study is that there must be a market study. It is very difficult to go to an individual and say to him, are you interested in water, because to your question he has five or six others, what is it going to be like, what do you think it is going to cost. He has lots of things he wants to know before he would come up with something, so the Department, for instance, realizes the necessity for making a study of markets, particularly in the Los Angeles area. What is the saleability? I think these indicate the Department is interested in the reclamation of water and the reuse of water. We have supported this in other ways, unofficially and officially perhaps in our recommendations, for instance, to regional water pollution control boards.

We are technical advisors to them on this matter of the possibility of reuse of water. Actually, of course, the Department of Water Resources only enters this from one standpoint and that is the source of water, and unfortunately, there are other aspects, the public health aspects. In other words, there are many things, perhaps, that water should not be used on.

You can't use it on this kind of crop, or you couldn't use it in this kind of area. These are over and above the considerations purely of reclaimed water as a source of supply.

SENATOR SLATTERY: One other question. On page 2, this 1,330,000 acre-feet is lost each year. Is that irrevocably lost? Is that every year when that million three hundred thousand odd gets lost, is that lost forever?

MR. INERFIELD: Well, if you notice that of that we estimate there are about 1,290,000 discharged to the ocean or to bays, and this is irrevocably lost, yes.

SENATOR SLATTERY: Then, do you think, do you feel that as a Department of Water Resources, do you feel an urgency in this matter, in the matter of pursuing this?

MR. INERFIELD: Yes, we do, and I think this Bulletin 80 that I'm talking about indicates that this is water which should be, if at all possible, put to a beneficial use.

CHAIRMAN TEALE: Senator Cobey and then I am next.

SENATOR COBEY: Mr. Inerfield, I judge that at least at the present time the Department feels that perhaps there is only about a maximum of what, 700,000 acre-feet that could be reclaimed that is now being irrevocably discharged, is that it?

MR. INERFIELD: Yes.

SENATOR COBEY: I'm just taking the figure.

MR. INERFIELD: Yes, about half.

SENATOR COBEY: 650,000 acre-feet?

MR. INERFIELD: Something like that, yes.

SENATOR COBEY: And as I recall it, you estimate the yield of your Feather River Project as 4 million acre-feet

roughly, and when we get into this field of reclaimed water at the present time, why you only see a maximum of about 650,000 acre-feet that isn't being reclaimed at the present time?

MR. INERFIELD: Well --

SENATOR COBEY: Or would you go beyond that?

MR. INERFIELD: I think that the quantity of water that will be discharged in the years to come may go up.

SENATOR COBEY: Yes, and as it goes up there will be more reclaimed?

MR. INERFIELD: Yes. I don't know whether you will be able to reclaim 50 percent of everything that goes, but presumably the possibility of reclaiming will go up if the quantity of the discharge goes up.

CHAIRMAN TEALE: I notice -- I have been looking at the two maps on the back of your presentation here. The first one is the location of waste water reclamation projects. You have a few spots on the map. The other one is location of major waste water discharges and you have a lot of spots on that. The question arises in my mind, what percentage of water diverted for use is consumed? In other words, what is the percentage as against the percentage discharged? How much do you discharge in normal uses in a city?

MR. INERFIELD: In a community?

CHAIRMAN TEALE: In a community, consumptive use?

Mr. INERFIELD: Well, it is almost the same. In other words, you have a community and there is a relatively small amount of consumptive use. The rest of it goes back out again. And there is some consumptive use, but it is small compared to

the use.

CHAIRMAN TEALE: 20 percent?

MR. INERFIELD: I don't know, 5 percent.

CHAIRMAN TEALE: All right. Then you also talked about the cost of treating water, and we assume this is water picked up from a river or picked up from a source, and the treatment that has to be given it before it is put into the mains for domestic use. Now, if the City of Sacramento discharges 80 percent or 90 percent of their water into the Sacramento River, how do you classify the works at Antioch, and Martinez, where they pick up the water for use? Is that a sewage reclamation project or is that a water treatment project, and if so, what is the difference in cost if there is a difference?

MR. INERFIELD: I think whether a plant is a sewage reclamation process or a water treatment plant depends upon the percentage of the source of supply that is sewage. In other words, if it is all waste or a large part of it is waste, of course, it is a reclamation plant. Where a relatively small amount of this material is in the water supply, it is a water treatment plant.

CHAIRMAN TEALE: Essentially, you are dealing with the same problem, but in a different magnitude?

MR. INERFIELD: To a different degree, yes, this is true. This occurs all the time, for instance, on the Mississippi where you have one community picks up water and discharges its wastes, and then it becomes a source of supply for another community downstream. They have lots more problems with the matter of water treatment, and we are learning more about the

inefficiencies and the incompleteness of water treatment as we study more and more. We never considered the possibility of nematodes, little types of worms, that apparently go right through treatment plants, because our criteria isn't adequate enough when we meet criteria that have been established. We don't take care of everything that might happen to this water as it is being treated, so I would say that where you have a source of supply which happens to have a polluted, if I can use this term, where you have wastes getting into it, you have to exercise a degree of caution and good judgment and efficient treatment to a higher degree than if your source of supply was completely clean. There are two aspects. One is you have clean water and then you keep it clean. This doesn't present too much of a problem. The other one, you have water that is sullied in some way and then it becomes more of a problem to make it suitable for use.

CHAIRMAN TEALE: Now, we are talking about transporting water across the Delta or the California Water Project to be transported south. In effect, we are dealing then with a polluted water supply to begin with, are we not?

MR. INERFIELD: Pollution in California is a legal term.

CHAIRMAN TEALE: I'm talking about the fact you have got sewage in it, haven't you?

MR. INERFIELD: Sacramento sewage gets in.

CHAIRMAN TEALE: Sacramento-San Joaquin waste water is going down to the Delta, so you mix good water with it and you have to take it out of the Delta, so you are going to have

a polluted water supply to some extent?

MR. INERFIELD: I can't say that it is polluted. I can't say it is.

CHAIRMAN TEALE: I can.

MR. INERFIELD: There is a legal definition of "polluted" and this doesn't come under those terms.

CHAIRMAN TEALE: I know there are some more questions by the committee but since this is a very technical problem, I'm going to ask that the committee allow Mr. O'Connell to ask some questions which he has and then we'll return to the committee. Bill, do you want to take it?

MR. O CONNELL: Yes. First of all, I would like to follow up on the line of questioning that was raised by Senator Richards in referring to the table on water quality tolerance for industrial use. Isn't it true that this table sets forth the quality of water which an industry in New England would be willing to use without question by direct diversion, say from the Androskoggin River into a papermill and without any treatment in the mill and then I'll follow that with a second question which is, there is no reason to believe that reasonably treated waters would not have additional value for industrial purposes, assuming the industry takes the responsibility for additional treatment?

MR. INERFIELD: Let me understand you, Bill. This first one, I recognize that these studies were developed in New England, true, and that probably a pulpmill would be happy to get this kind of water. I agree with you.

MR. O CONNELL: In California they would be very happy,

too.

MR. INERFIELD: I agree with this.

MR. O CONNELL: It is that point I wish to bring out, that there is no such thing as a standard for industrial water supply either for making beer or for cooling, and that what you do in an industry, if you decide to locate a steel mill at Fontana for other economic reasons, you use the water that is available and attempt to process it yourself to meet something like these quality characteristics. There is no such thing as a standard for industrial water use in any area of the industrial activity.

MR. INERFIELD: This is true. If you notice, at the head it is called water quality tolerance. It doesn't say standards. This is because of the fact that Mr. O'Connell brings out.

MR. O CONNELL: So that a table like this, to a degree, can only be used as a guide that would say if in a reclamation program you produced water that had the characteristics shown here, there wouldn't be much question about its being used for the purposes indicated, and I think the outstanding illustration of the meaninglessness of this sort of table is a turbidity qualification of 50 parts per million on cooling. I know that you have seen many waters that were used quite successfully for cooling that wouldn't come within 5 times that figure.

SENATOR COBEY: This is basically, then, a market guide. If you had water of this quality you should have this market for it?

MR. INERFIELD: It is purely a guide.

MR. O CONNELL: This would be a marketing guide which could be used without additional treatment by the purchaser?

MR. INERFIELD: That is right.

MR. O CONNELL: I felt that was a point that should be brought out.

MR. INERFIELD: As usual, you are right.

MR. O CONNELL: Now, going back to this emphasis on dialysis treatment, I wonder if there was any impression left, for example, that reclamation of the sewage of the City of Sacramento would indicate the use of dialysis treatment of that sewage? Aren't we only talking about trying to reclaim flows, perhaps, that have oil field brines in them or flows perhaps as we find in Ventura County with a high water softener addition where we are talking about removing total salts as a necessary step to sewage reclamation, or to put it precisely, would you visualize the need for salt removal in reclaiming the sewage of the City of Sacramento?

MR. INERFIELD: No, in reclaiming the City of Sacramento sewage, no.

MR. O CONNELL: Or in the City of San Francisco?

MR. INERFIELD: Bill, let me answer in total this way. I tried to indicate here the possibilities of treatment. Now, I can't visualize, I hate to exclude anything. In other words, I can't say now for sure there will never be under any circumstances anyplace where this kind of treatment for sewage will not be indicated in some way. In general, to treat the City of San Francisco I don't think this is in the cards, and I think the same thing goes for Sacramento.

MR. O CONNELL: I didn't want to leave the impression, this committee with the impression that dialysis was an essential step in the reclamation of the major amounts of sewage that are available for reclamation in the State of California. I note one other comment in which you say there is no place where sewage is being reclaimed for industrial use, and I wonder whether that is being recycled for industrial use. I wonder whether reconsideration of the situation at Kaiser steel mill in Fontana might not put it into the category of reclamation of sewage as an essential step in recycling?

MR. INERFIELD: I accept this, sure, absolutely.

MR. O CONNELL: I just wanted to indicate that one of the pioneer efforts has been made industrially. Then, the last question I would like to ask is, I would like to ask do you have some rather more elaborate comments, and frankly I don't see hardly a reference to the reclamation for reuse for recreational purposes, such as in Golden Gate Park and at the Santee operation Would you care to comment as to the requirements and as to the opportunities for beneficial use or reuse of water in those circumstances?

MR. INERFIELD: Bill, I'm sure when the State Health Department makes their presentation they will discuss this. I would like to say the Department of Water Resources considers these wastes a source of supply and as such,all sources of supply should be considered with respect to some kind of use. Whether or not these particular sources can be used for certain uses lies with another agency, not with the Department of Water Resources. All we can do is point up the areas where these

things might be possible, point out these areas where these uses are being made and, like I said before, to keep track of what happens in the field and to stimulate where we can.

MR. O CONNELL: One of those reuses, as important as industrial reuse and agricultural reuse, is probably recreational reuse, isn't that so?

MR. INERFIELD: I agree with you, this is true.

MR. O CONNELL: That's all.

CHAIRMAN TEALE: Senator Richards, do you have another question?

SENATOR RICHARDS: Recognizing that there are all kinds of variables, as you have of course correctly stated on this matter of reclamation, can you nevertheless state a rough conclusion of a comparison between the costs of reclamation versus the costs of salt water conversion?

MR. INERFIELD: At the present time, yes, roughly. I think at the present time that the reclamation is cheaper than sea water conversion.

SENATOR RICHARDS: Then, to take the next step, if I may, where you have the potential reclamation of a large amount such as the Hyperion outfall and you also are at the waters' edge, you have unlimited sources of sea water, would it be by presently known methods cheaper to convert an acre-foot at Hyperion than it would an acre-foot of Pacific Ocean?

MR. INERFIELD: Sea water conversion just has not reached the point of economics where it could compare. I have to say it this way, Senator. We have to talk again about criteria, reclaim to what point? Don't forget sea water

reclamation, if we are talking in terms of demineralization by distillation, we are talking about a water which has become essentially devoid of minerals and then this can perhaps be mixed with some other supply. When we are talking about reclamation, there are different degrees. For instance, as an example, I don't think we could ever compete with those industries that are able to use salt water for cooling, as an example. This is no matter how you reclaim. So you have to talk in terms, because salt water for cooling is adequate and it does a reasonably good job, so when we talk about comparing reclamation and demineralization, we have to talk to what degree.

SENATOR RICHARDS: And again taking the very rough criteria, of making it fit for human consumption.

MR. INERFIELD: I don't know whether we are able to reclaim water in the processes that I have described without going into some vapor phase or perhaps percolating it down into the ground water to mix with other waters and bring it back out. I don't think we can reclaim water which is safe for domestic consumption, for drinking water at this time.

SENATOR RICHARDS: Lastly, Mr. Chairman, I merely want to comment that I think the Department has indicated through the preparation of this document today its real interest in this field and I certainly on that point, since they have already indicated they are preparing Bulletin No. 80, do you have a target date on the estimated time of availability of Bulletin 80?

MR. INERFIELD: Actually, the thing has been reviewed and it's in the process of getting final corrections on this now. It will be about two months.

SENATOR RICHARDS: Thank you.

CHAIRMAN TEALE: Senator Johnson, do you have any questions?

MR. JOHNSON: We have all pure water in the Sacramento Valley.

CHAIRMAN TEALE: Any further questions by members of this committee? Mr. Inerfield, I want to thank you very much for your courtesy in answering our questions and also, again, for the preparation that has gone into your document here today. The committee will now recess until 2:00 p.m.

(Thereupon the noon recess was taken.)

TUESDAY, OCTOBER 31, 1961, 2:15 O'CLOCK, P.M.

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CHAIRMAN TEALE: We will call the meeting to order again. We will proceed with the agenda. The first witness this afternoon is Mr. Frank M. Stead, Chief of the Division of Environmental Sanitation, Department of Public Health. I would like to take this opportunity to mention the presence here today of Carley Porter, Chairman of the Assembly Water Committee. He's been invited to sit up here, but declined because he has to leave in the middle of the proceedings. Glad to have you, Mr. Porter. Mr. Stead.

MR. STEAD: Mr. Chairman, I am Frank Stead, Chief of the Division of Environmental Sanitation, California Department of Public Health. The statement which I would like to read, I believe, supplements without going over the same territory the material covered in the Department of Water Resources' statement. I call your attention, however, to the fact which is pointed out in the opening pages, that I use the term "water reclaimed from sewage" in a somewhat more restricted and narrow sense than the broader term used by the Water Resources. I think you will catch this change in use of the term as we go along.

This statement is intended to discuss the public health aspects of reclamation of water from sewage.

It is essential at the outset to draw a clear distinction between, on the one hand, the broad field of inland sewage disposal, in which the water in sewage effluents ultimately reaches and blends with the surface or ground waters of the State and, on the other hand, the fundamentally different

and distinct field of true reclamation of water from sewage. In the case of inland sewage disposal, we are starting with raw sewage, a troublesome and useless commodity which constitutes a threat to people, land and water, which is unsightly and odorous, yet which is produced daily, year in and year out in great quantities and which must be disposed of daily at the rate of its production. The person or agency finding himself or itself in possession of this liability would like to throw it away in its raw state, but public health and water pollution considerations require that it be first treated and then disposed of in a manner which will not injure people, land or water. The problem then resolves itself into finding the simplest and cheapest method of modifying raw sewage so that it can be discarded into the environment. The fact that some indirect benefit to society may result from inland sewage disposal by replenishment of the inland waters of the State is incidental.

In the case of reclamation of water from sewage, we are dealing with an entirely different type of problem. Here the question is: Does the raw or treated sewage constitute an attractive raw material for the production of water which someone will buy and use as a substitute for normal water taken from wells or streams or imported in aqueducts? It is a matter of great importance to note that such water would truly be "water" in the eyes of the law and not subject to the many restrictions placed on sewage or sewage effluents in the public health statutes of the State. In other words, a new resource would have been produced by modern technology from an existing waste.

Reclamation is not a substitute for sewage disposal

but an adjunct to it. It consists of withdrawing from a going sewerage system at appropriate points and times, sewage or sewage effluent which can be converted into saleable water at a net cost competitive with the cost for other water in that locality.

To sum up, then, every community or area must first provide itself with a sewage collection, treatment, and disposal system. Having done this, the opportunity then exists to select points in the system where sewage of good chemical quality may be subjected to reclamation procedures which will produce water ready for direct use to meet local needs. After reclamation has been established and proven, it will curtail the subsequent need for expansion of the sewage system but will never replace it for three reasons:

1. Some sewage is not suitable for reclamation.

2. Some sewage is at areas and elevations where there is no market for raw water in the quantities involved.

3. Unless huge storage facilities are available, conventional disposal systems are needed for times when there is no demand for water in these quantities.

The following comments are confined to water reclaimed from sewage.

Direct Uses of Water Reclaimed from Sewage. Water reclaimed from sewage may, in theory at least, be put to all the varied uses which apply to normal water. At this point in time, however, it is probably most pertinent to consider the direct uses presently made of highly treated sewage effluents in this State and those that are under serious consideration for water reclaimed

from sewage. These uses are named and briefly discussed in the following paragraphs:

1. Irrigation of Food Crops. Irrigation of agricultural crops was the earliest form of beneficial direct reuse of sewage in California. In the early days "sewer farms" were common in the Central Valley and in Southern California. In sparsely settled rural areas raw sewage was used on crops not intended for human consumption. Gross odor nuisance was the factor which ruled out this practice in the early thirties. When sewage treatment, capable of stabilizing sewage sufficiently to prevent gross odors was required, communities usually found it cheaper to provide longer outfalls, partial treatment and disposal of effluent by dilution in the fresh or salt waters of the State so that sewage farming on a large scale did not develop.

When food crops intended for human consumption are irrigated with sewage effluent, the hazard of infection of the food with pathogenic organisms is introduced. To meet this hazard it is necessary that the effluent be reliably disinfected, and before sewage can be disinfected it must be first treated so as to remove practically all of the suspended solids and dissolved organic matter. Standards describing the nature of treated effluent that may be used to irrigate food crops have been established by the State Department of Public Health. These standards, set forth in Title 17 of the California Administrative Code, are now met by very few of the treated sewage effluents in the State.

2. Irrigation in Public Places. One of the direct

uses of water reclaimed from sewage in which many communities are currently interested is the watering of municipal parks, cemeteries and golf courses using sprinklers. The idea is particularly attractive in that large volumes of water are involved and the peak demand comes at the time of year when streamflow for dilution of sewage is at its lowest. No clearcut public health standard for reclaimed water for this purpose has been formally established. A fairly high degree of sewage treatment is automatically required to prevent odors, as well as clogging of spray nozzles. The uncertainty has to do with the standard needed to prevent transmission of disease. Assuming that precautions are taken to prevent children or other persons from drinking directly from the faucets, the human contact consists primarily of children playing on wet lawns. The hazard of inhaling or swallowing air-borne droplets is not considered to be critical. Lacking a specific standard for this type of direct use of reclaimed water, health departments in this State currently utilize the standard pertaining to irrigation of food crops above referred to.

3. Recreational Impoundments. One of the newest proposals for direct use of water reclaimed from sewage in California pertains to the impoundment of such water so as to form lakes which are used for boating and other recreational purposes. Such a proposal is now under study in San Diego County. Because of the great likelihood of ingestion of some water by recreationists and the knowledge that all the water was once sewage, there is agreement among health departments that as a minimum, the drinking water standards as they pertain to

bacteria should be met and all of the organic matter of sewage origin should be completely removed or transformed in the treatment and reclamation process. The remaining question concerns the viruses in sewage which are more difficult to remove or destroy than bacteria. The problem is complicated by the fact there is not available a sensitive and quantitative laboratory test for viruses which can be routinely applied. Further study is needed before this use of water reclaimed from sewage can be endorsed.

4. Industrial Uses. Many industries which use large quantities of water are located convenient to sewage treatment plants and therefore constitute natural customers for reclaimed water. What is not always realized is that water used in most industrial processes, and perhaps this should be changed to "many industrial processes," must meet exacting requirements, one of which is uniformity of chemical composition and another is freedom from suspended material. Furthermore, in many industrial processes, bacterial content must be kept down. For these reasons conventional sewage effluents have not been particularly attractive to industries in this State and little industrial use has been made of existing sewage effluents in California. All this would change overnight if water reclaimed from sewage, which was comparable in all respects to normal water, were available in industrial locations. In fact, industries probably will furnish one of the main outlets for such water in the future, an extremely pertinent factor being the avoidance of the heavy pumping lifts required to transport reclaimed water to agricultural areas.

Water reclaimed from sewage, if it meets industry's own requirements for processing water, will probably pose no serious public health risk if it is kept separate from water for drinking purposes. Industry has a long experience with zoning off water used in processes involving toxic materials and, at most, disinfection would probably meet the health needs.

5. Direct Recharge of Drinking Water Aquifers. At the last session of the Legislature a law was enacted permitting the direct recharge of drinking water aquifers with water reclaimed from sewage, subject to requirements of the State Department of Public Health. Research and field experience during the past ten years have demonstrated that sewage effluents can be injected into underground aquifers through wells if certain conditions are maintained. In effect, these conditions mean that the sewage must have virtually all of its suspended material and dissolved organic material removed by treatment including filtration. Sewage treated to this degree can easily be disinfected by chlorination, which itself is a desirable adjunct to the injection operation hydraulically. The research has also demonstrated that bacteria and most organic matter travel only short distances through the soil in aquifers. These factors would seem to infer that the way is now clear for reclamation projects involving injection of water reclaimed from sewage on a large scale. Only two difficulties remain to be resolved. They are the question of mineral content of the injected water and the question of certain organic chemicals. Mineral content of sewage is not a constant thing and consequently, an elaborate and constant monitoring program must be

maintained to prevent injection of toxic or injurious inorganic chemicals.

In the field of organic chemicals the two current concerns are pesticides and detergents. In the well-known "Montebello Incident" some twenty years ago, a single slug of weedicide passing through a sewage treatment plant in a matter of a few hours, resulted in making water unpotable for several years in wells over a several mile radius from the point of discharge.

The problem of detergents is too well known to need more than mention. Most sewage from urban areas contains from 2 to 11 parts per million of detergent. Less than half of this is removed in conventional sewage treatment and 1 part per million can cause taste and foaming in domestic water. Furthermore, detergents travel through aquifers far more readily than bacteria.

It should be noted that the behavior of virus in ground water has not been explored. Consequently, we cannot ignore this potential hazard if water reclaimed from sewage is injected into a water well and promptly withdrawn for domestic use without aporeciable dilution.

6. Direct Replenishment of Pristine Waters. California has many areas of pristine waters which have not been defiled with sewage nor polluted with industrial wastes. One such area is Lake Tahoe. Three kinds of direct human use are made of the waters of Lake Tahoe. First, water is taken through over 200 submerged inlets to furnish drinking water for over 20,000 people Secondly, the surface of the lake serves thousands of people as a site for boating, fishing, water skiing and swimming. Finally,

the sparkling blue waters of the lake serve as a source of continuing deep enjoyment and satisfaction to tens of thousands of people on the watershed who may never actually venture out onto the lake itself.

To protect these three kinds of uses both State and local levels of government in both California and Nevada have maintained for almost fifty years a consistent policy of prohibiting direct discharges of sewage or sewage effluent into the waters of Lake Tahoe. The threefold purpose of this policy is to prevent contamination of drinking water, prevent pollution impairing recreation on the lake, and prevent the impact of the compounds in treated sewage which promote the prolific growth of algae and other aquatic organisms which would impair the attractiveness of the lake waters when viewed from the land. The acute water shortage at Lake Tahoe points up the need to conserve water. Land disposal by percolation and hillside spraying has almost reached its limit. The complete reclamation of sewage effluents in the Tahoe basin to convert them to water having none of the attributes of sewage (including aquatic organism nutrients) constitutes the only solution to water and sewage problems in the Lake Tahoe basin compatible with the three uses above described.

Present Status of the Art. Generally, treatment processes in the sanitary engineering field are described in order of their removal efficiencies as primary, intermediate, secondary, and "complete".

Sand filtration (tertiary treatment) of sanitary sewage which has been given complete treatment, will produce a water

nearly free of oxygen-demanding substances and bacteria, but the common salts (chlorides and sulphates) and many minerals are in no sense removed in the process. Of concern is the failure of known treatment processes to effectively remove synthetic detergents (ABS). Grease, oil, gasoline, alkalies, acids, and poisonous chemicals which may be discharged into sewers cannot be eliminated by ordinary waste treatment methods.

The most complete and efficient types of treatment utilized today do not of themselves produce from sewage, water of a quality that is potable. The factors of dilution, time, and self-purification, which must follow sewage treatment, are essential to raise the quality of water to the point where it can be withdrawn and treated for domestic use or used in the processing of food.

Sands and gravels upon which waste water may be applied for ground water recharges are highly efficient in removal of bacteria and oxygen-demanding substances from the applied water. Minerals, certain taste-producing chemicals, and synthetic detergents on the other hand are not substantially removed by percolation, and consequently, dilution with ground water before withdrawal may be necessary if these substances are present in the wastes.

In order to properly design treatment facilities, it is necessary to know the composition and treatability of the raw product. In some cases, wastes may contain substances that cannot be sufficiently removed for the use planned for the reclaimed water. If possible, the sources of the particular contaminant may be found and excluded, or the project must be

abandoned or redesigned for purposes where quality requirements are less exacting. These remarks apply to conventional sewage treatment processes. Very likely, where sanitary sewage is to be reclaimed for ground water recharge, the waste water to be treated must be taken from sewers above industrial areas. The chemistry of sewage originating from industrial areas will vary with the type of industry, and will alter with the technological changes in industrial practices and development of new products. Chemicals, particularly organics, in concentrations as low as one part per billion (one ten millionth percent) can produce tastes. Others, such as certain radioisotopes, have human toxic effects in even lesser quantity if ingested. The development of adequate micro-analytical laboratory methods to assay waters containing certain industrial sewages has not kept pace with the industrial advances in product manufacture.

Waste treatment facilities which use mechanical equipment are subject to mechanical failure and power outages. Most of the biological processes used in waste treatment are sensitive to the toxicity of metals such as those in plating wastes or spills of acids of alkalies into the sewers. Interruption of treatment could seriously impair the success of a reclamation plant producing water whose usage requires high quality.

These problems were recognized in planning the 10 million gallon per day water reclamation plant under construction by the Los Angeles County Sanitation Districts where reclaimed water will be spread in the Whittier Narrows area of the San Gabriel River basin for ground water recharge. A site was selected where the raw material diverted from the sewer is

essentially domestic sewage with little industrial wastes. Should any of the processes used by interrupted for any reason, the plant can be immediately shut down. The Golden Gate Park water reclamation plant in San Francisco, the first of its kind, has these same features.

Little is known about the survival of viruses through treatment processes and in receiving waters. Although enteric organisms abound in sewage, modern sewage treatment can remove a large proportion of the disease-causing organisms. The pathogenic bacteria, protozoa, and intestinal worms can be dealt with, but the problem of virus survival, particularly hepatitis virus, must be better understood before public health authorities can proceed with confidence in endorsing projects where the public may be in intimate contact with treated sanitary sewage.

Research in this area is under way and it is probable that the Federal, State, and local health agencies may jointly undertake a comprehensive study in San Diego County where reclaimed sewage is used to make an artificial lake used for recreational purposes and thus obtain more information on the virus and other problems involved.

In summary, the present status of the art of reclaiming water from sewage may be described as follows:--the currently used methods of artificial treatment of sewage produce effluents which must be modified by factors of further natural or artificial purification before the resulting water is suitable for the types of uses described. These factors of needed further purification to convert sewage effluent into "water" have in the past been provided by returning effluents to the natural surface

waters of the State or by applying effluents to land. It should be entirely feasible to accomplish this same conversion of sewage effluent to water using manmade structures incorporating the same natural purification factors of filtration, time, dilution, and biological action as now operate in nature so that a commodity which is truly water, with none of the attributes of sewage, may be produced for direct reuse.

Limiting factors on this process appear to be the mineral content of the sewage, certain specific dissolved organic compounds, and a lack of ability to accurately assess the hazards of viruses. Research now under way or planned should remove or at least clarify the last two of these limiting factors during the next few years. The limitation of mineral content may also be eliminated as the technology of desalting water continues its present rapid development. The combined removal of both organic and inorganic chemicals from sewage may well prove to be more feasible and feasible at an earlier date than desalinization of brackish or salt waters of the State. Since this point was touched on this morning and is a crucial one, I would like to repeat this last sentence. The combined removal of both organic and inorganic chemicals from sewage may well prove to be more feasible and feasible at an earlier date than desalinization of brackish or salt waters of the State.

It is the firm belief of the State Department of Public Health that reclamation of water from sewage is a forward step in environmental health and that the public health problems involved can be solved in favorable locations without undue burden of cost.

CHAIRMAN TEALE: Thank you very much, Mr. Stead. Senator Williams, you have a question?

SENATOR WILLIAMS: No questions.

SENATOR DOLWIG: I have a question, Mr. Chairman.

CHAIRMAN TEALE: Senator Dolwig.

SENATOR DOLWIG: I might just take you up on that and ask Mr. Stead, have you people dug into some of this past history of where they were reclaiming sewage water in the past and used that as a basis for any future studies?

MR. STEAD: You are referring to the early experiments in 1929 and 1930 in Griffith Park?

SENATOR WILLIAMS: Yes, not only there, but the City of Pomona. Pasadena, as I recall, sold the fertilizer out in front of their plant for $60,000. The thing that has been puzzling me all along is some of these agencies that said you could do it then. Now, we get all these agencies that say you can't do it now because the cost is excessive and we don't know enough about it and we need more studies.

MR. STEAD: The point we have tried to make in this presentation, Senator Williams, is that within the limitations of chemical content of sewage, conventional treatment processes are capable of producing an effluent which can be put to some of the uses, but that to be put to uses involving intimate human contact, will require further improvements in the art of taking conventionally treated sewage and removing from it the attributes that make it unfavorable for these further uses.

Pomona is an illustration of the principle I mentioned, that an area first provides itself with a sewage collection and

treatment facility and then seeks opportunity to take from that system water of good chemical quality and put it to an appropriate use, and that is exactly what was done at Pomona.

With respect to Pasadena, the activated sludge from the treatment plant does have value as a soil conditioner and fertilizer, and experience of many years has demonstrated that this can be done sometimes at a profit in reclaiming activated sludge. Milwaukee is not the only area that reclaims its activated sludge. As you know, in Golden Gate Park in San Francisco, all of this, both the liquid and the organic material is put to beneficial use in Golden Park.

Now, referring to the early work at Griffith Park which was referred to earlier in reclamation to produce "drinking water" from sewage, here we were dealing with 1929 sewage from households only. It was chemically of good quality. It had none of the detergents and other organics that plague us today, and by taking a full panoply of sewage treatment, including activated sludge treatment and following it with a full panoply of water purification including coagulation, filtration, activated charcoal treatment and chlorination, they were able in those days to demonstrate a commodity which, except for mineral increment resulting from household use, met all of the going criteria of the Public Health Service drinking water standards. But if one were to continue this process several times over, there would be a gradual, not a gradual but a markedly rapid rise in the total solids. There would be increased in organic constituents which today would make the water entirely unusable. That sewage today would probably have about 4 parts per million of detergents and

the effluent from that same plant today would not be usable.

SENATOR WILLIAMS: One more question right at that point. The people have kept referring to detergents. It is something new as compared to way back in the thirties, but I'm wondering if the detergent is as hard to deal with as that lye soap they used to use in the thirties. According to one chemist I talked to he said if they could get rid of the lye soap he thought they could reclaim water a lot cheaper than they thought it might cost them then. Of course, I realize you have this inflationary spiral.

MR. STEAD: The soap, Senator Williams, was physically removable and digestible on conventional treatment and one type of detergent which is usually referred to is ABS which is quite resistant to the biological treatments that are now applied. Now, our Department prepared for the State Water Pollution Control Board a preliminary statement of where we now stand in the assessment of the problem of detergents and their ability to be coped with in sewage treatment. If your committee is interested in having a copy of this report, I'll be very glad to make it available. The points that we are trying to make in this statement are not a pessimistic forecast, but an optimistic forecast, that with conventional treatment some uses can be applied today, but that with complete reclamation one can look forward to creating a commodity which is in all respects like water and may be put to all of the uses to which normal water is put, and we believe that one must not come to the conclusion that by assessing this in 1940 and finding this economically unfeasible we forget the subject. It must be reassessed every few years and

in different locations, and we believe that the potentialities of reclamation with present technology are by no means explored to their fullest in California right now.

SENATOR WILLIAMS: That'S all I have.

SENATOR DOLWIG: Mr. Stead, I'm going to refer my questions to page 3, irrigation of food crops. So that we understand what I'm talking about, I think you remember a number of years ago because of the water shortage in Santa Clara County, there was considerable activity insofar as using reclaimed sewage water from San Francisco, shipped down to Santa Clara to take care of the water shortage there, and now I'm just using that as an example. This could be true of most areas in Southern California, too, could it not?

MR. STEAD: Yes.

SENATOR DOLWIG: I mean you have the same factors involved?

MR. STEAD: Yes.

SENATOR DOLWIG: I was wondering there at the end you say these standards which are in the California Administrative Code, are these the standards which have been set up by the Department of Public Health?

MR. STEAD: Yes, these were adopted as regulations and they are entitled "Regulations Concerning the Use of Sewage and Sewage Effluents on Food Crops," and they call for virtually this complete treatment with very reliable disinfection. Now, it is this reliable disinfection that is seldom achieved in sewages which are disposed of by dilution.

SENATOR DOLWIG: Let me ask you a specific question,

if you know what the circumstances are, would it be possible to take San Francisco sewage and ship it and have it treated properly and then use it for irrigation purposes in Santa Clara County for their crops?

MR. STEAD: Yes, sir.

SENATOR DOLWIG: And can this be done at the present time to meet the standards that are set up here in your California Administrative Code?

MR. STEAD: These standards are technologically completely feasible. They require some other place for sending the sewage at times of difficulty, but with these qualifications these standards are achievable and have been achieved.

SENATOR DOLWIG: Well now, if we know what standards are required, technologically is it possible at the present time?

MR. STEAD: Yes, sir.

SENATOR DOLWIG: If it is technologically possible, could this water be economic?

MR. STEAD: In order to answer that question, Mr. Dolwig, one has to consider the geographic relationship and also whether the sole use that is made is irrigation of a food crop, because --

SENATOR DOLWIG: Let's keep it to that one.

MR. STEAD: The irrigation of a good crop, as you know, would furnish an outlet for an effluent perhaps 20 days a year, 20 irrigating days only, you see, and during the nonirrigation season then the extra investment and transportation works and so forth are producing no value unless another use is woven into the picture.

SENATOR DOLWIG: Well, would you like to express an opinion as to whether this could economic at the present time? I don't want to tie you down to anything definite.

MR. STEAD: Well, it seems to me that the best prospect for considering reclamation of sewage is on a basin or area basis in which one agency or some time of an organization has the opportunity to forecast the variety of uses and their geography and their timetable, forecast the layout and the concept of the sewage treatment plant locations, the sewage reclamation sites, and if this can be planned from scratch, then the ultimate in sewage reclamation can take place. It is very difficult to move into an existing situation and try to take the sewage where it is usually not in the right place, where segregation of the most troublesome mineral wastes has not always been done, so unless it is planned initially with reclamation in mind, then one is greatly hampered to apply reclamation to an existing sewer system as he finds it. But more and more, with the great growth and expansion of sewage systems on an areawide basis, as in the San Gabriel Valley in Los Angeles County, the studies there indicate that if one had the opportunity to plan this thing pretty much all the way through the sewage operation, take account of the water use operations and the reclamation operations and fit these things together in the right relationship, then the opportunities are indeed promising.

SENATOR DOLWIG: Do you think it would be feasible to have a pilot study or a project in the State now in an area like San Gabriel Valley to determine whether this, as you mentioned, technologically can be worked out, and of course, you have the

question whether it can be worked out from an economic standpoint. Do you think that it would be wise for the Legislature to appropriate money for a pilot study of this type?

MR. STEAD: I think the study you are going to hear about tomorrow at Whittier Narrows is the very ultimate in the proper use of governmental money to seek answers. Here is a multimillion-dollar operation which the various departments of the State utilize for study purposes and at the expenditure of less than $50,000 a year one will perhaps in a few years reap the benefits of a multimillion-dollar experiment that did not have to be paid for with research money because it was a real operating venture in the first place. The Santee Project offers the same type of opportunity, and I believe that existing technology permits one to design with confidence certain reclaiming operations that apply sewage to land by percolation, by irrigation if the sewage is good chemical water, and what we are now seeking is two things, the additional reclamation necessary to permit a wider variety of uses including direct recreational use of impoundments on the one hand and being able to say what will we do when reclamation reaches the barrier of too high an inorganic chemical content, andthe point that I intended to make there, is that if we could make a breakthrough in reducing the total mineral solids of sewage from, say 2,000 parts per million down to 200 parts per million at a greatly less cost than the same number of millions of gallons of brackish or salt water, perhaps this, then, gives us even a new horizon for comparing the process of recycling by reclamation and keeping water right within a basin even further.

Now, this type of comment should be considered in long-range planning with one's eyes perhaps 40 or 50 years ahead or 20 or 30 years ahead at least.

SENATOR DOLWIG: Do you feel that the studies that are now being made will give us the answers from a technological and economic standpoint, whether it is feasible to go into the reclamation of water on an area basis?

MR. STEAD: Qualitywise, Whittier Narrows studies are going to give us some answers on detergents, and the Santee studies are going to give us some answers on the virus. These are the two factors that are most important on potability of water for domestic purposes. As to the economic factors, the studies referred to by the Department of Water Resources would be the pertinent answer there. With respect to the balance of salt, we see no quick, easy solution of this, but I still wish to repeat that one may breach this barrier perhaps better when dealing with sewage than when dealing with brackish water.

SENATOR DOLWIG: How soon do you think we will have those answers?

MR. STEAD: I believe the detergent question and the virus question will yield to research within a 5-year period.

SENATOR DOLWIG: Thank you very much.

CHAIRMAN TEALE: Senator Richards.

SENATOR RICHARDS: This does not bear directly upon your report, but you will recall the question that came up in the testimony of prior witnesses wherein it was felt that the Department felt it would provide the proper answer and that in this new concern developing over the possibility of radiation

within the water supply, taking the hypothetical example of a situation where suddenly the radio count goes way up in a given area and there develops conflict as to what level is safe, what level is not safe, and what should be done about it, the question is, who in Government provides the answer?

MR. STEAD: In this State it will be the Department of Public Health. Under present legislation the responsibility is so placed.

SENATOR RICHARDS: And what is the Department now doing in this field? In other words, does it have answers as to the level of acceptable tolerance?

MR. STEAD: Levels of acceptable tolerance under peacetime conditions have been established by the National Committee on Radiation Protection, and these same values have been incorporated in the Atomic Energy Commission regulations for permissible exposure of occupationally employed persons in their work places. These are exposures to gamma ray radiation as well as X-ray and radiation in foods and air and water. These are standards of virtually no expected damage either somatically or genetically. These are considered to be a judgment of an intelligent threshhold of exposure to which employed persons may be exposed. One tenth of these values are the going values that are used for protecting the general population and we are using, therefore, this general population figure in assessing levels of radioactivity in air, water and food in this State and in making the interpretations that we make.

SENATOR RICHARDS: When they speak of micromicrocuries in measurement of air, do you use the same scale in terms of water?

MR. STEAD: Yes, we do. We use this minimum factor, micromicro meaning a millionth of a millionth of a curie, but in air it is one micromicrocurie per cubic meter. That is a large volume. In water it is 10 micromicrocuries, I mean 100 micromicrocuries in a liter of water and in food it is per gram, but I mean it approximately is all based on a daily intake which, if extended over a long period of time, will not create an unsatisfactory body burden of any of the materials taken in air, food or water.

SENATOR RICHARDS: Local officials, should they desire to do so, could now obtain the scale and measuring devices against which to scale out these standards of their own water supply?

MR. STEAD: They could make the measurements at the present. Many water companies are making measurements and more and more of the domestic water companies will be. On a statewide basis the Department of Public Health carries on a statewide environmental surveillance of levels of radioactivity in air and rain and snow and soil and vegetation and milk and meat, shellfish and so forth. Six other departments participate, including those that are here today in the collection of this material. Water companies submit samples. Samples are collected from water systems, from sewer systems of the State. At the present time the State Department of Public Health is doing most of the laboratory measurements. The disaster council is doing a smaller portion and in fact, the disaster office is doing laboratory work on the stream samples and the Department of Public Health on virtually everything else.

SENATOR RICHARDS: Do we know the rate of decay of contamination caused by radiation and also the accepted methods, if any, for physical purification of already contaminated supplies?

MR. STEAD: The answer to your first question is yes. If one accepts these peacetime acceptable levels, and to date we have been able to operate well within them, then there need be no concern on the part of the public of their being given a dangerous exposure. We operate on these standards. The State Health Department has not set these standards. We have adopted or accepted these standards because they are the dependable, reliable, safe standards in this country and the result of the scientific community's best thinking. Now, as to corrective measures that could be taken if water or food exceeded this value -- danger levels, if they are to be exceeded from fallout, are more likely to be exceeded in food than either in water or in air. Food, fortunately, yields to some corrective measures, because if the material is rapidly decaying, it is possible to work with the food industries to hold those foods off the market for a sufficient length of time for the major portion of the radiation to decay. This type of procedure is not available to us in water systems, but fortunately, with respect to the public food supply, it is. Consequently, we feel confident that any event likely to occur from nonwartime activities can be handled with a complete surveillance program and interpretation of the program and staying within these conservative peacetime standards. This is our firm expectation. This is not true in case of warfare.

SENATOR RICHARDS: Well, Mr. Chairman, I think all my questions have been answered save one. I didn't pull out of that last answer and I don't expect to delineate all of the technical details, but do we or do we not know approved methods of anything for purification of a contaminated water supply, said contamination being caused by nuclear radiation?

MR. STEAD: In the first place, the material that we are talking about is usually in particulate form. Whether it comes down dry or whether it comes down in rain, it is in particulate form and the factors of sedimentation that take place in water impoundments are in themselves perhaps the best and most dependable mechanism of reducing and removing radioactivity from water. However, the most important factor is time, and if one's immediate drinking water within the distribution system is not contaminated, but only the water in the terminal reservoir, then a matter of a month or so is an extremely important factor of safety. If we go even further back into the streams on the natural waters of the State, it is this factor of time that stands as a barrier between the population and radioactive material.

SENATOR RICHARDS: It is measurable, predictable?

MR. STEAD: It is predictable. Some of the water treatment processes are effective in terms of 50 percent removal, but this, of course, is not enough when one is dealing with large quantities, so that by taking advantage of natural sedimentation and of time and of treatment, one can do a very respectable job of protecting himself, and the point that I wish to make is that the surveillances here, the observations

being done, we are not proceeding on the basis of hope, we are proceeding on the basis of information.

SENATOR RICHARDS: Thank you.

CHAIRMAN TEALE: Mr. O'Connell.

MR. O CONNELL: Well, Mr. Stead, one point that appears in both your presentation and Mr. Inerfield's presentation that leaves a question in my mind, is whether we are talking about reclamation of sewage for, say, industrial water supplies on the theory that this will be the total supply. Presumably, 90 percent of the water that is used by large industrial water users is used for cooling purposes, and in cooling operations the presence of organic matter is an advantage. I'm not even sure but what the presence of detergents wouldn't even be an advantage.

Now, what is your appraisal of the practicality of a two-source supply where 90 percent of the large industrial water users' cooling requirements, namely the cooling water requirements, are provided as they were in Pasadena at one time, and as they could be at Richmond? Are these stringent requirements applicable under those conditions?

MR. STEAD: I believe that both industries and communities and agriculture have needs for waters of different qualities for different purposes, and specifically on your question on industry, if industry's needs for water for cooling are for water having certain attributes which are met by an existing sewage effluent, then of course no reclamation procedures need be applied to that effluent before use by industry. Reclamation might need to be considered in the next use that is made. I did not intend to imply that water must be all things to all

people and that there is a single quality of water during use which is uniform. I do believe that we must move toward a higher concept of quality of the waters of the states themselves, but I believe that during use water may be modified, it may be impaired, it may be degraded, as long as the responsibility is discharged of not returning it to the environment in this condition.

MR. O CONNELL: Isn't it also true that as a source of cooling water, namely, the major requirement of the major water-using industries is that an inadequately treated effluent has considerable advantages? I refer you back to the cooling towers in 1929 of the City of Pasadena's municipal light plant where the corrosion rate was greatly reduced due to the presence of the remaining organic matter in the old activated sludge plant?

MR. STEAD: There are cases, Mr. O'Connell, as you know very well where by a fortunate combination of circumstances it may happen that an ingredient in a sewage effluent has benefit. I don't believe one should make this generalized, though, to quite the extent that you are inferring. I believe that industry across the board, including the food industries with which you are very familiar, for example, the water used in cooling in the food industries, for the cooling of cans, this must be of very hard quality and it is keeping these factors in mind that we recognize that complete reclamation may be needed before waters may be used in these industries.

MR. O CONNELL: Perhaps in cooling of cans in the food industry you would use one tenth of one percent of the total industrial use of industry in the State of California. I want

to emphasize that there are tremendous advantages in the large industrial water use to an effluent of the character of the effluent from the old Pasadena Sewage Treatment Plant, and this, to me, was the place where you have a big market for reclamation and conservation, and in none of this discussion have I heard any emphasis on conservation. We have emphasis on costs. The reason thatthe sewage treatment plant of the City of Pasadena is no longer in operation is that it was more economical at that point of time without respect to conservation of our natural resources to connect to the sanitation district system and dump what had been used water, reused water, into the Pacific Ocean. And it would appear in this picture, don't you feel, that conservation should enter into the considerations as well as economics?

MR. STEAD: Without question. Conservation is really in the last analysis what we are talking about. In my opinion, one of the two factors that have stood in the way of reclamation that perhaps haven't been mentioned here, is in balancing the costs and credits of reclamation. One should credit himself, should credit the reclamation operation, as Mr. Inerfield pointed out, not only with the cost of treatment that the sewage would have had to have anyhow for its normal disposal -- one should credit himself with the cost to the State at large of any degree of degradation of waters of the State, and the second factor that is not always taken into account is this, that a person who is in one business, let's say an industrial venture or a sewage disposal venture, the idea of complicating his existence by entering into another complex business is not attractive. For example, we see a sawmill that burns its waste because it is

not attractive to that sawmill to go into the reclamation and pressed wood business, but another enterprise usually comes along and takes the raw material from a variety of these and then gets into the business. Now, it seems to me that we will see reclamation when new reclamation governmental agencies appear and we cannot expect water companies of the State to get interested in reclamation, or public works departments of cities. It's got to be a new concept and a new kind of industry that says here is a raw material, true it was somebody's end product, and here is a market and they convert the raw material to meet the market. When they do, I believe that many of the industries will buy water and it may indeed be that the specification for cooling water is a liberal one.

MR. O CONNELL: There is one other question that I have. There have been references to the use of ABS as the detergent causing tastes. It is my understanding, and you correct me if I am wrong, that per se ABS does not create a taste. There are some detergents that do, but if the taste develops, it is because somebody used the detergent to produce a clean rag, and it is not the detergent, the ABS per se in particular that produces the taste.

MR. STEAD: Actually, this question has not been tested out nearly as thoroughly as it should, and of course, the real violent taste would come when you had a detergent reacting with something else and the detergent, therefore, in waste water is used detergent. However, some very preliminary work done in the Department of Water and Power in Los Angeles, of which I have only a verbal report, did indicate that in the laboratory ABS

could be detected by a panel at a part and a half per million.

CHAIRMAN TEALE: Any further questions by the committee? Thank you very much, Mr. Stead. Another Department of the State that is quite interested in water and pollution is the Department of Fish and Game, and we have with us Jack C. Fraser, Water Projects Section of the Department of Fish and Game. Come forward, Jack, and have a chair, and let's have it.

MR. FRASER: Mr. Chairman and Members of the Committee, my name is Jack Fraser, Chief of the Water Projects Branch of the Department of Fish and Game.

Because fish and game resources are so dependent upon water, the Department of Fish and Game is interested and active in matters affecting both water quantity and quality. The reclamation or reuse of wastes affects both quantity and quality of water supplies and it is to this area of activity as it relates to the State's water quality management program and more specifically as it relates to the fish and wildlife resources that I wish to direct my comments.

Comprehensive Water Quality Management Needed. First of all, let me establish my frame of reference regarding waste water reclamation. I choose to think of it as an integral and inseparable part of a strong, statewide program of progressive water quality management aimed at protecting the water supply for all uses. Therefore, I am looking at waste water reclamation or reuse as a means of protecting and augmenting the basic water supply.

In California as well as throughout the country, a number of well-established trends in water use point to the need

for a strong water quality management program.

Accompanying the population explosion we have witnessed a heavy increase in the per capita consumption of water. The per capita "municipal" consumption (including domestic and industrial uses) has now risen to ovee 700 gallons per day per person in the United States.

This accelerated water use is the result of increased economic production, more "water hundry" household appliances, increased irrigation, and an unprecedented urbanization. Urbanization causes increased demands for water and a decrease in the quality or quantity, or both, of locally generated surface and ground water supplies. The answer has usually been found in importation of water from other areas.

Californians today are transporting water great distances to serve urban areas, and the State Water Plan calls for even greater transfer of supplies. The cost of delivery keeps rising and the sources of supply for new projects are diminishing. We can easily visualize the time, in the not-too-distant future, when every drop of the State's water will be precious to the over-all development and well-being of all Californians. We cannot afford to jeopardize the quality of any of the basic sources of supply. Sacramento River water, for example, will be used throughout central and southern California for domestic, agricultural, industrial, recreational and many other uses. We can ill-afford to tamper with its quality but perhaps we can make it stretch farther through reuse.

Pollution control and waste water reuse or reclamation will surely remain essential elements in the management of water

supplies in California. Both elements form an integral part of what we consider a desirable comprehensive water quality management program. We suggest that such a program requires coordinated action in at least the following basic elements.

1. Enunciated objectives and policies emphasizing protection of the quality of water for all uses.

2. Laws and regulations designed to protect water quality and to stimulate actions needed to carry out other phases of the over-all water quality management program.

3. Enforcement of anti-pollution and water quality protection laws.

4. Monitoring to provide continuing water quality data for determining trends and possible signs of danger.

5. Waste treatment must be constantly improved and expanded by industry and municipalities.

6. Watershed management to reduce siltation and dissolved solids content of streams and water supplies. In general, I would like to emphasize the need in California for good watershed management.

7. Reuse and reclamation of waste waters as a means of augmenting and stretching existing supplies and reducing pollution.

8. Research to provide the knowledge and the mechanisms for carrying out the various phases of the program. Without research any water quality management program will be incapable of true success. Research will most certainly be the determining factor in the extent to which waste water reclamation can augment basic water supplies.

The foregoing are suggested as essential elements for a comprehensive water quality management program which in turn we consider necessary to the State's welfare. We look upon waste water reclamation as one of these essential elements, but not necessarily the most important.

I am pleased to say that in my view California is developing a water quality management program along these lines.

Waste Water Reuse and Reclamation as a Part of a Water Program and its benefits to Fish and Wildlife

The benefits of waste water reclamation to fish and wildlife resources can be divided into direct and indirect benefits with the latter having the most significant and longer lasting effects.

Indirect benefits are realized as a result of reduced discharges of wastes to natural streams, lakes, bays or ocean. In addition, through the augmentation of local water supplies, the pressure on the basic water supply is reduced. Since fish and wildlife resources are principally dependent upon this basic water supply in the streams, anything that can ease the pressure on that supply will be beneficial.

Industry should be given credit for the accomplishments it has made in the reuse of water. It is estimated that the present nationwide average reuse of water by industry approaches 100 percent or complete reuse at least once. Industry usually has been motivated in this respect by pollution control pressures and the rising costs of high quality water. Regardless of the motivation the savings of water and reduced waste discharges have been beneficial to fish and wildlife.

Industrial wastes take on a special significance when we consider the industrial expansion predicted for the future and the nature of these wastes. It has been predicted that the index of industrial activity will rise from the 125 of 1954 to around 400 by 1980 and, perhaps, 1,180 by the year 2000. About 400 new chemical substances are created each year at the present pace of industrial activity and research. A corresponding complexity in the wastes is occurring. Many of the wastes remain relatively stable or are reduced in nature very slowly. Many are toxic. Knowledge about these wastes is developing too slowly and the methods of reclaiming waters contaminated by them are for the most part unknown.

Among others, the pulp and paper industry has done much towards reducing its high water consumption through reuse, reclamation, and development of techniques for extracting useful by-products from wastes. By-product development in industry frequently results in water savings and reduced pollution.

Agricultural uses of reclaimed water provides perhaps the greatest potential for stretching our water supplies. However, much research is needed to give answers to the problems created by irrigation of various soil types with different types of low quality water.

One of the greatest losses of waste water occurs at the larger municipalities along our coast where vast quantities of potentially reclaimable water are discharged to the ocean. Fish and wildlife resources supported by the water supply source would generally benefit from municipal waste water reclamation.

In addition to the indirect benefits cited above, we

have also witnessed direct benefits resulting from the use of reclaimed waste water for fish and wildlife production. Often such production has been obtained as an unintentional "bonus" of the reclamation or waste treatment process. We could cite numerous instances where properly constructed sewage and industrial waste stabilization ponds have been used for fish and waterfowl production. A classical example is Lake Mitchell which receives the sewage discharge of San Antonio, Texas, and supports considerable waterfowl hunting.

Sewage stabilization ponds are becoming an increasingly popular method of waste treatment and much can be said for their value, both directly and indirectly, for fish and wildlife purposes. In many cases the final effluent is of far better quality for fish and wildlife purposes than is the final effluent produced by conventional treatment processes.

The Santee County Water District near San Diego has recently asked us for advice on the development and management of a recreational fishery in a twelve-acre artificial lake to be supplied by reclaimed water from their sewage treatment plant. Earlier this year San Bernardino County was contemplating the development of a 130-surface-acre fishing lake in the Prado basin using reclaimed sewage water. We can look forward to growing interest in this type of development by municipalities and sanitation districts. Unfortunately, research on fish production in waste water ponds has been very limited and therefore we may not immediately achieve maximum fishery benefits from such ponds.

Perhaps the most significant waste water reclamation

project with the greatest potential for wildlife may take place in the San Joaquin Valley. In order to overcome various drainage problems, a drain system for the San Joaquin Valley is needed and is contemplated in the State Water Plan. Such drainage may affect the 204,000 acres of wetlands in the San Joaquin Valley which support some 3½ million waterfowl and hundreds of thousands of other migratory birds. We are presently working with the Department of Water Resources to devise a plan for maintenance of the San Joaquin Valley waterfowl carrying capacity. One of the several methods being considered is the use of drain water for waterfowl habitat production. Although the drain water would probably be unsuitable for agricultural use, our studies indicate it would be suitable for developing or maintaining waterfowl habitat. It may also be suitable for production of warm water fishes. Extensive reuse or reclamation of drain waters may be the key to perpetuation of waterfowl resources in the San Joaquin Valley.

In summary, I have attempted to emphasize that waste water reclamation should be considered as an inseparagle part of a strong, progressive water quality management program for the State. Such a program should have enunciated objectives and policies, good laws and regulations, firm enforcement, monitoring, improved waste treatment, watershed management, reuse and reclamation of waste waters, and lastly, but very important, research.

Reuse and reclamation of waste waters can be and in many instances has been shown to have direct benefits to fish and wildlife resources as well as long-term and, perhaps more

significant, indirect benefits resulting from pollution prevention and water saving effects.

The State should stimulate programs of waste water reuse and reclamation as a part of a water quality and water supply management program. Looking forward to the future demands on the State's water supplies we can ill-afford to do otherwise.

CHAIRMAN TEALE: Thank you very much, Mr. Fraser. You brought out some points here I was not aware of. Are there any questions on the part of the committee? You must have made yourself very plain. Thank you.

MR. FRASER: Thank you, Mr. Chairman.

CHAIRMAN TEALE: We will now hear from Mr. Paul C. Bonderson, Executive Officer of the State Water Pollution Control Board. Mr. Bonderson.

MR. BONDERSON: Mr. Chairman, and Members of the Committee, my name is Paul Bonderson, Executive Officer of the State Water Pollution Control Board. It is surely a privilege to appear before your committee and provide you with a brief explanation of the Board's activities in the field of reclamation and reuse of waste waters.

With increased demand and limited supplies of water in California, it was only logical that the State Board would consider the possibilities of reclaiming sewage and industrial waste discharges. Soon after its activation in 1950, the Board sponsored the first of a series of research projects on this subject. I am pleased to submit, for the committee's files, copies of six published reports on these projects. I should

also like to file with your committee a report that might not have otherwise have come to your staff's attention on some legal aspects of waste water reclamation. This was a paper that was delivered by Adolph Moskovitz, at that time a Deputy Attorney General, at a conference on waste water reclamation at the University of California back in January of 1956. From an engineering point of view this is a very informative paper.

Our agency's concern in this area is two-fold. First, we recognize that waste water reclamation provides a supplemental source of water. The importance of this aspect has been covered by the testimony of others, and I will not comment on it at this time.

The second, and more important concern from our standpoint, revolves around the fact that waste water reclamation, when feasible, reduces the pollution problem by converting waste waters into an economic asset rather than an economic liability.

This presentation will cover three subject areas: (1) the State Board's past activities in the field of waste water reclamation, (2) the Board's plans for the immediate future, and (3) participation of the federal government in this field. My remarks will not touch upon the regulatory aspects of programs for reclaiming waste waters. However, I would like to digress for a moment here due to the fact that you did ask a question relative to this subject this morning, that is, on projects such as the Whittier Narrows and at Oceanside where ground waters could be affected, that is, waters of the State could be affected by a reclamation project, these projects must file a report or the discharger must file a report with the

regional board and the regional board establishes requirements that they must meet which will assure that the waters of the State will not be adversely affected qualitywise by such an operation.

The first waste water reclamation research project sponsored by the Board was contracted with the University of California in 1950. It was concerned primarily with investigations of rates of percolation through different soils, methods of spreading, and chemical and bacteriological changes in wastes when percolating through various types of soils. One important conclusion reached by the research contractor was that a bacteriologically safe water can be produced from settled sewage if the liquid passes through at least four feet of soil.

The second project was contracted with UCLA and was concerned principally with an analysis of three aspects of the problems of reclaiming waste waters for irrigation purposes: (1) the relation of methods of utilizing waste waters to ground water pollution and to contamination of crops, (2) the extent of nuisances resulting from reclaimed waste waters, and (3) mineral pickup in the waste waters of representative California communities and industries.

Until recently, replenishment of ground water basins by injection of reclaimed wastes had not been tried. The reasons for this were largely technical and resulted from lack of conclusive information on (1) the travel of pollution and (2) the practicability of injecting water containing organic and inorganic solids directly into an aquifer. Because of these unknown areas, the State Board in 1951 contracted with the

University of California for a field investigation on (1) extent and rate of travel of pollution with ground water movement, (2) use of recharge wells as a means of waste water disposal and ground water replenishment, (3) methods of operating recharge wells, and (4) economic aspects of recharge through wells. The numerous findings of the investigators lead to the general conclusion that reclamation of sewage waters by direct recharge into underground waters is practical and that operational considerations rather than public health considerations are the controlling factors.

The fourth project in this field was conducted over a three-year period starting in 1954 and was contracted with the University of Southern California. This research was designed primarily to provide technical assistance and guidance to local agencies that were operating or planning to operate waste water reclamation facilities. The first year's report summarizes present-day practices of waste water reclamation and reviews both foreign and domestic operations where utilization of waste waters is practiced. The second year's report represents the first attempt by the University to conduct its research as a series of cooperative ventures with interested agencies. Two principal studies were started. The first concerned reclamation of liquid, digested sludge in San Diego County; the second concerned reclamation of raw sewage lagoon effluent at Mojave, California. The final report in this series documents results of the second year of study at San Diego and Mojave, as well as additional studies initiated at the Marine Corps Base at Twentynine Palms and the Naval Ordnance Test

Station at China Lake.

The State Board has recently become concerned with the problems resulting from synthetic detergents in sewage. One facet of these problems has a direct bearing on waste water reclamation proposals, since this is one of the most difficult pollutants to be removed from waste waters before they can be reused. Last year the Board asked the Department of Public Health to prepare a report that would provide the Board with general background information on the detergent problem so that the Board could formulate a research program that would aid water pollution control authorities. The Department's report, titled "Sanitary Engineering Aspects of Household Detergents and Some ABC's of ABS", has been filed with the Committee.

So much for what has been done in the past. Now to comment briefly on plans for the immediate future. The Board has assigned funds for waste water reclamation research in the current fiscal year and has budgeted for additional studies in 1962-63. We are now attempting to get underway two research projects in this field.

The first involves the Whittier Narrows Waste Water Reclamation Plant. We have asked the California Institute of Technology to prepare a research proposal that will encompass a study of the following technical factors associated with the operation of this reclamation project: (1) removal of pollutants (particularly detergents) in the treatment process, (2) mixing and diffusion of the percolated waste waters, and (3) effects of the reclaimed waters on the quality of the ground waters at point of use. It is hoped that this research can be

started by January.

To expand our knowledge of the effects of synthetic detergents in ground water recharge, the Board proposes to contract for a field study in an area affected by detergents. The Department of Water Resources has been asked to submit a proposal for a study to be undertaken at the Colton Narrows in the San Bernardino area. The project will have the objectives of (1) assisting the Santa Ana Regional Board in the conduct of its regulatory responsibilities, (2) determining the fate of detergents percolating into the ground waters, and (3) developing the fundamental data that will aid in the evaluation of mixing and dispersion within a ground water basin. A January target date also has been set for starting this investigation.

I would like to call to the attention of your Committee an extensive research project initiated about a year ago by the U.S. Public Health Service. This undertaking has been titled "The Advanced Waste Treatment Research Program".

The objective of the project is to develop an economically feasible technology that will provide means for removing from waste waters those contaminants and pollutants which are not removed by sewage and industrial waste treatment processes now used for the control of water pollution. Or, stated in another way, the objective is to develop a treatment process which will completely renovate waste waters, thereby making them suitable for any and all beneficial uses.

To assist the Public Health Service in carrying out this project, a nine-member advisory group has been impaneled, of which I am a member. This is a long-range project, and the

Service has developed a projected budget and program for a ten-year period. The sequence of activity will be:

1. Screening of ideas. (Completed)
2. Feasibility studies. (Currently under way, 1961-63)
3. Pilot plant studies. (1963-65)
4. Field evaluations. (1965-68)
5. Demonstrations. (1968-70)

The present budget is approximately $1/2 million, and it is envisioned that a total of almost $15 million will be required for the ten-year period. Attached to this statement for the Committee's information is a copy of a six-page report from the Robert A. Taft Sanitary Engineering Center, dated May, 1961, summarizing the views of the Public Health Service on the problem, the proposed program, and the treatment processes to be given consideration.

If this ambitious and far-sighted program bears fruit, it is almost certain to result in the reclamation and reuse of waste waters on a much greater scale than present technology permits. Before concluding, I should like to just refer the committee to the next-to-the-last page, that is page 5 of the attachment and just run through the treatment processes that are being studied through this program of the United States Public Health Service. These are all physical-chemical separation processes. The first is adsorption on activated carbon, on inorganic materials and on synthetic polymers. The next is electrodialysis, electrolysis, evaporation, extraction of contaminants and extraction of water, foaming, freezing, hydration, ion exchange, oxidation, and as I understand it, the screening

of ideas has indicated that each and every one of these processes at least on a bench scale can completely renovate a waste water. A major question is can this be done economically and can technology be developed to carry this into full practice.

This concludes my remarks. I would be pleased to answer any questions that the committee may have regarding the activities of our agency.

CHAIRMAN TEALE: Thank you very much, Mr. Bonderson. I would like to ask a question. Turning back to page 3, you say down there about line 8 or 9, "The numerous findings of the investigators lead to the general conclusion that reclamation of sewage waters by direct recharge into underground waters is practical." You mean pumping of your effluent from the treatment plants right directly into recharge wells?

MR. BONDERSON: Through recharge wells, yes, sir.

CHAIRMAN TEALE: And "that operation considerations rather than public health considerations are the controlling factors." By that are you implying that there is no particular public health consideration involved in it? In other words, that the organic material or bacteria or virus that goes through the treatment plant will be taken care of as a matter of percolation. Is that what you are getting at there?

MR. BONDERSON: No, sir, not exactly. The researcher did not take into consideration virus. Their investigations were limited to bacteria and on the basis of the bacteria analysis, they concluded that this did not pose a public health problem, that the travel of the bacteria in the aquifers was quite limited. Obviously, you wouldn't want to put a producing

well, a domestic well in the immediate vicinity of one of these because there is a certain amount of travel.

CHAIRMAN TEALE: Let me ask you this. When you have a recharge well, you are not pumping from the same well. Don't you have a recharge well here and a pumping well over here?

MR. BONDERSON: That would be the case, I'm sure. The study involved putting down a recharge well and then around the periphery of this there was a series of producing wells.

CHAIRMAN TEALE: At what distance?

MR. BONDERSON: I don't recall specifically. They ran from 50 feet on out to 300 or 400 feet and then they would reinject sewage effluent into the recharge well, then collect samples from these wells out in the surrounding aquifer and make chemical bacteriological analysis of the waters that travel through the aquifer.

CHAIRMAN TEALE: Have they had any disagreement with the Department of Public Health in this project, or did you work with them?

MR. BONDERSON: The Department has been very familiar with this and as the report of phrased, I don't think the Department has found any reason to disagree with it. This might be an oversimplified statement that they might not agree with, but the full text of the report, I'm sure, they would be in concurrence with.

CHAIRMAN TEALE: As a water pollution board are you going to concern yourselves much with the problem of viruses?

MR. BONDERSON: Well, there is supposedly a separation of responsibilities. Public Health implications fall within

the regulatory realm of the Department of Public Health. We are interested in those phases of it that do not fall into the Public Health, all the other aspects of it. Yes, the Board is concerned with this, though. However, we have no research plan on this subject. As Mr. Stead pointed out, we are trying to work with them to support them in some work down at Santee.

CHAIRMAN TEALE: On the Santee Project I might say that some of us saw that project last month, and it was my understanding at that time the project was in operation, kids were rowing their boats and sailing on this lake. It was very pretty, incidentally, and it was my understanding at that time it was determined it would be safe. I gathered the impression from the Public Health man that it had not been approved yet. What has been the activity of the Water Pollution Board on this project?

MR. BONDERSON: The regional board has set requirements at the point where the sewage treatment plant effluent is spread on the gravels upstream from the ponds. The regional board's regulatory aspects ends at that point.

CHAIRMAN TEALE: At that point would the waters at the spreading grounds, would they be suitable for recreational use?

MR. BONDERSON: I would say not. Then it goes into the spreading grounds and into the aquifer and into the gravel basin there and then it is withdrawn for use in the ponds for recreational purposes. The regional board, as I understand it, is not involved in the withdrawal and use in the ponds.

CHAIRMAN TEALE: You feel, then, that if there was no withdrawal and use in the ponds, if the water came out of

the spreading grounds and went into the San Diego River, there would be no problem as far as pollution is concerned?

MR. BONDERSON: That would be my opinion.

CHAIRMAN TEALE: Let me go over to page 5, and you use the word "contaminants" and "pollutants". At lunch I had a discussion about the use of these two terms. Could you define them for me and see what you mean by "contaminants" and what you mean by "pollutants"?

MR. BONDERSON: By the dictionary definition they are one and the same. By the California law they differ slightly.

CHAIRMAN TEALE: Will you enlighten me?

MR. BONDERSON: Contamination is actually hazard to health whereas pollution is a degradation of water quality that is not an actual hazard to health but does have an adverse effect upon some other beneficial use.

SENATOR COBEY: One defines the jurisdiction of the Public Health Department and the other the jurisdiction of the Pollution Control Board.

CHAIRMAN TEALE: No matter how big the chunks are, if they are not a menace to public health, they are pollution?

MR. BONDERSON: Yes.

SENATOR RICHARDS: What is a polymer?

MR. BONDERSON: I'm afraid I can't answer your question, sir.

SENATOR RICHARDS: I'm referring to page 5.

MR. BONDERSON: Yes.

SENATOR RICHARDS: Well then, my only other question was on this matter of apparent cleaning the supply by passage

through four feet of soil at the early part of the report. The first query, should a layman understand this to mean that irrespective of the quantity of the supply to be purified, if it drops through or is forced through four feet of soil, it comes out the other side relatively purified, sufficiently for human use?

MR. BONDERSON: Here again, this report was based upon bacteriological considerations and not virus. Virus were not studied in this undertaking. Obviously, there are many different types of soil, but if you have a relatively tight soil that is not loose gravel, I think it could be concluded from this undertaking that this would be bacteriologically safe water.

SENATOR RICHARDS: Well now, again I presume that this would vary if you kept using the same soil?

MR. BONDERSON: The conclusion reached in this --

SENATOR RICHARDS: If you have a box of four feet of soil and you kept using it as your method of purifying, it is going to pollute the soil eventually and would have to be replaced?

MR. BONDERSON: No, sir, the report was that this amount of soil would permanently and continuously result in the self-purification to a point where it no longer posed a bacteriological hazard.

SENATOR RICHARDS: Well then, all of our technical chemical efforts would seem to be totally unnecessary. Just have a box of four feet of soil and you have got it made.

MR. BONDERSON: I said bacteriological. This will not necessarily take out the organics or detergents.

SENATOR RICHARDS: That was my last question, was on the question of detergents. The detergent situation still remains irrespective of filtration through soils, is that right?

MR. BONDERSON: Yes, sir. There is some exchange and reduction initially in some soils, but apparently the soil finally reaches the capacity and the detergent then passes through unaffected or undiminished.

SENATOR COBEY: One thing that has intrigued me in the testimony today, why is it that there is no buildup in the processes or the materials, let me put it this way, no building up in the materials you use as a polluting agent? That is one of the things that has intrigued me in this whole reclamation of sewage process. You can evidently use the same materials over and over again and they remain equally efficient. I mean they remain as efficient as they were initially. Is that generally true? Do you see what I'm getting at?

CHAIRMAN TEALE: I think what you are talking about is that you have the contaminants on the top because the big chunks settle out, and the rest is filtered.

SENATOR COBEY: Why can you continue to use the same gravels that you use again and again? Why is there not a build-up of the contaminant within the plant itself?

MR. BONDERSON: The phenomenon you are talking about is a biological one and you are dealing with a life-death characteristic primarily, and by physically filtering it out, and finally the organisms will not reproduce in this environment and eventually they die and the process is just continuous.

SENATOR COBEY: That four foot of soil that Senator

Richards is talking about, you can use the same four feet of soil over and over again?

MR. BONDERSON: That was the conclusion of this investigator.

SENATOR COBEY: With no loss of efficiency at all?

MR. BONDERSON: That was the conclusion of this investigation.

SENATOR WILLIAMS: Still looking on page 3, "The numerous findings of the investigators lead to the general conclusion that reclamation of sewage waters by direct recharge into underground waters is practical." Now, are we talking about water for human consumption or are we talking about water for irrigation purposes?

MR. BONDERSON: As it relates to practical?

SENATOR WILLIAMS: Yes, what are you talking about in this statement here?

MR. BONDERSON: These are the conclusions of the investigator. The Board has not endorsed or rejected this.

SENATOR WILLIAMS: I mean, what is the investigator talking about, water for human consumption?

MR. BONDERSON: The investigator would indicate if you get sufficient distance away from the recharge well, as far as bacteriological considerations are concerned, this would be a safe supply for domestic purposes.

SENATOR WILLIAMS: For domestic purposes?

MR. BONDERSON: Yes, sir.

SENATOR WILLIAMS: That is what he's getting at. All right. Now, I think the University of California was studying

this situation and they might have been studying it at the time I visited their plant because of this contract that you people had entered into with them, but the question I would ask you now is this, where in this new series of reorgnization that the Governor has put through is the Water Pollution Control Board? Is that under its own heading or is that under the State Water Board or where are you people situated now?

MR. BONDERSON: We are one of the agencies within the Resources Agency.

SENATOR WILLIAMS: Under the National Resources Agency?

MR. BONDERSON: Yes, sir.

SENATOR WILLIAMS: Now, has this report been given to the Natural Resources Agency for review?

MR. BONDERSON: No, sir.

SENATOR WILLIAMS: This report by these investigators.

MR. BONDERSON: I thought you meant my report.

SENATOR WILLIAMS: No. I realize you wouldn't be here without an okeh from some of the superiors above you of which you seem to have quite a number. I mean the investigators, has their report been given to the Department heads or apparently it hasn't been given to your group at all, to the control board. It hasn't been sanctioned by them, anyway?

MR. BONDERSON: Well, they are received by the Board. This is standard procedure. They are received by the Board and they publish them, but they neither endorse nor reject them. Obviously, if they did have something major or found something major in their minds wrong with one of these reports, we wouldn't publish them, but there could be some finding in there that

there might be some question about. These are technical studies that the Board feels they should not endorse. We are not qualified to do this, but at the same time these should get into circulation and be of value to the many people who receive these.

SENATOR WILLIAMS: Well, who does the Pollution Control Board think should evaluate those reports?

MR. BONDERSON: The individual who is going to make use of these. This is of value to the Department of Public Health. It would be of value to Water Resources. It will be of value to local agencies. They will have to go through individual reports and evaluate them in the light of their specific problem.

SENATOR WILLIAMS: Well now, how would the little City Council of Porterville be able to evaluate that report when they don't have anybody down there, we'll say, that has the ability to evaluate, and at least I'm sure they don't have anybody in that category now. Should this be evaluated by the Natural Resources Department, this new super-super department we created?

SENATOR COBEY: Agency.

MR. BONDERSON: You use a poor example. It has a very competent man that can evaluate this.

SENATOR WILLIAMS: You mean Porterville?

MR. BONDERSON: I thought you said Visalia. The consulting engineer for a community should be in a position to evaluate these. One of the difficulties that you would run into if you proposed to have somebody evaluate this work would

be you wouldn't find the Universities interested or would even agree to do the work for the Board if their work was to be given a stamp of approval or rejected. I think they would feel this would be an encroachment upon their academic freedom.

SENATOR WILLIAMS: I think that's all I have, Mr. Chairman.

CHAIRMAN TEALE: Thank you very much. We will reconvene the meeting at 10:00 o'clock in the morning. Thank you.

(Thereupon the meeting was recessed.)

WEDNESDAY, NOVEMBER 1, 1961, 10:15 O'CLOCK, A.M.

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CHAIRMAN TEALE: We will now call the meeting to order. I want to apologize to the rest of the committee members for being a little late myself this morning. Our first witness is Arthur Bruington, Division Engineer, Water Conservation Division, Los Angeles County Flood Control District. Mr. Bruington.

MR. BRUINGTON: Thank you, Mr. Chairman and Members of the Committee. As Senator Teale mentioned, I have charge of the water conservation division of the Los Angeles County Flood Control District. I have titled the presentation today "Waste Water Reclamation in Los Angeles County," attempting to cover the field, perhaps, in a general way, and I will call your attention to the fact that it does not include Antelope Valley activities.

The reclamation and reuse of waste water is considered to be an integral part of water conservation activities in Los Angeles County. In a water-short area, it is imprudent to waste into the ocean millions of gallons daily of slightly-used water, which with purification treatment and proper safeguards can be economically and safely reclaimed and reused.

A study prepared for Los Angeles County's Board of Supervisors indicated that in January, 1958, 465 million gallons of sewage per day were wasting to the ocean. Of that amount, 280 million gallons per day were amenable to reclamation and reuse. Flow of sewage now has increased to about 540 million gallons per day; a portion of this flow increase probably is also amenable to reclamation and reuse. To understand the role reclaimed water may have in the future, it should be noted that

280 million gallons per day is the equivalent of approximately 300,000 acre-feet per year, which is about 25 to 30 percent of the present total water requirements of coastal Los Angeles County. The State Department of Water Resources estimated in its studies for the California Water Plan that the ultimate water requirement would be at least double that of the present. One serious limitation to the reuse of waste water is the normal increase in dissolved salts which sewage incurs. Care must be taken to properly limit reuse of such water so that it will not cause water in underground storage to contain excessive amounts of these dissolved salts. Thus, although the supply available from reclamation of waste water can represent a significant contribution to meeting future water demands, it is not considered to be a substitute, nor even a competitor, with supplies planned to be imported from Northern California.

As compared to the many and varied uses of water obtained from natural runoff sources, the ways reclaimed waste water may be used are limited. Generally speaking, it is the domestic sewage component of sewage flows which is being considered for reclamation in Los Angeles County. As much as practical, industrial waste flows are being concentrated in parallel sewer trunks for ocean disposal. Probable uses of reclaimed waste water in Los Angeles County fall in three categories. One use would be for parks and irrigated agriculture. Because of the declining role of agriculture in Los Angeles County, it is unlikely that any waste water reclamation program of significant scale will be developed specifically for agricultural purposes. At a few strategic locations, reclaimed waste

water probably will be used in large parks for irrigating grass and plants, and for maintenance of recreational lakes. Another use would be in industrial processes where there is no public health hazard. The largest such use is apt to be for cooling purposes.

Most of the use in Los Angeles County, undoubtedly, will be for ground water replenishment. In general, there are two ways this replenishment may be accomplished. One is by ponding treated waste water on the surface of permeable soils to allow percolation of the water downward through the soil pores to the ground water body. As this water travels in the soils just beneath the ground surface, additional purification occurs. The second method of replenishment is the injection of treated waste water through wells directly into the ground water body. Treated waste water used for the latter purpose must be much more highly purified. Both methods have been tested and some projects are in operation in Los Angeles County at the present time.

In 1948 and 1949 tests were performed in the vicinity of the cities of Whittier and Azusa concerned with the surface spreading method of ground water replenishment using reclaimed waste water. These small-scale tests indicated that surface spreading would provide an economic and safe means of using reclaimed waste water for ground water replenishment.

The positive results of these tests were used by the Los Angeles County Sanitation Districts in planning the integration into its sewerage system of existing, small, under-capacity treatment plants in the Pomona area and the Azusa area.

In both instances, the County Sanitation Districts constructed new facilities to carry away flows exceeding existing plant capacities and continued operation of the existing facilities for waste water reclamation. Treated water from the plants in Azusa is placed in ground water storage by ponding and percolation, while treated water from the Pomona plant is sold to agricultural interests for irrigation, with any excess flows allowed to percolate in a natural wash downstream of the plant. Altogether, these facilities reclaim about 6,500 acre-feet per year at very low costs.

In the Whittier Narrows area of the county, a large-scale demonstration waste water reclamation project has been initiated. Whittier Narrows lies at the downstream edge of the San Gabriel Valley. The valley's development is largely domestic with a relatively minor amount of industry. All of the sewage from San Gabriel Valley drains through Whittier Narrows and, because of its domestic source, is of relatively high quality. The demonstration project will involve the construction of a treatment plant which will reclaim 10 million gallons per day (about 10,000 acre-feet per year) of waste water for use in replenishing the downstream ground water supply. The plant will use the standard-rate activated sludge treatment method, which is a well-established, time-tested process for obtaining a well-purified reclaimed water. This water will be delivered to nearby permeable streambeds and offstream spreading areas and allowed to percolate.

I brought along today a few photographs to highlight points. There are two photographs that will be passed out.

They show the two fairly large spreading areas that exist in the coastal plain just downstream from Whittier Narrows location. The spreading area, the larger spreading area in the picture is called the Rio Hondo spreading ground. It is located on a concrete-lined channel, the Rio Hondo Channel. You can see the white strip of concrete-lined channel running down through the picture. The spreading grounds on the east, which in the picture would be on your right, has 450 acres in it. The ground is partly covered with water in the picture and only about two-thirds of the grounds are shown in the photograph.

The photograph is from a plane looking northward upstream and in the background you can see Whittier Narrows Dam if you look very closely. Off in the upper right-hand corner there is another strip that looks like a channel and that is the San Gabriel River. We'll speak of that in a moment.

On the left side of the photograph along the concrete-lined channel there is another strip of open-bottom spreading area. This represents about 100 acres and extends well below the bottom edge of the picture. It is the old streambed, and when the concrete lined channel was put in the streambed was purchased at the same time and developed into additional spreading area.

Part of the water from the Whittier Narrows waste water reclamation plant can be routed down the concrete-lined channel and by means of diversion gates in the channel where the channel changes from dark gray to light gray, can be diverted to either side of the channel for percolation.

While we are looking at that photograph, the Whittier

Narrows waste water reclamation project would be in the Whittier Narrows Reservoir area just upstream of the gates which you can barely pick out in Whittier Narrows Dam. Actually, it will be a little farther upstream.

The other photograph shows the San Gabriel spreading grounds. This ground has an acreage of about 100 acres. The stream running along its side is San Gabriel River and is open bottom and with the ultimate flood control development planned in Los Angeles County, this portion of the stream will stay open bottom. Consequently, we developed that stream to its maximum capacity for percolation also.

You will notice in the stream levees which we call hook levees and they tend to cause the water to cover more of the streambed, percolate more in the available area, and they can be replaced rapidly with a tractor. The reclaimed waste water can be diverted into the San Gabriel River.

We plan to divert the reclaimed waste water into this stream also so it could be percolated in either the stream or in the spreading grounds. Before we leave the photographs I would like to point out one other problem that undoubtedly will occur with percolation of reclaimed waste waters and that is the intensive development around the spreading areas.

Whittier Narrows is an ideal site for such a water reclamation activity. In addition to having a good source of supply and nearby facilities for percolation of the reclaimed water, the plant site is located within the reservoir area of Whittier Narrows Dam, which will serve to maintain a semi-isolation from the public; and there are large-capacity trunk

sewers downstream of the plant into which the sewage can be diverted if temporary disruptions in plant operations should occur.

Of interest is the fact that this project involves the cooperation of four local agencies. The County of Los Angeles is loaning money for the construction of the plant (without interest because of the demonstration nature of the plant); the Los Angeles County Sanitation Districts has designed the plant and will construct, operate, and maintain it; the Flood Control District will distribute and spread the reclaimed water; and the Central and West Basin Water Replenishment District will purchase the reclaimed water from which funds the County of Los Angeles and the Los Angeles County Sanitation Districts will be repaid. It is expected that the first delivery of the reclaimed water will occur in mid 1962. Present estimates of the cost of this reclaimed water indicate that it can be placed in underground storage, available to be withdrawn for general use, for less than $20 per acre-foot, including amortization of plant facilities at a rate of 4 percent interest. At the present, about 67,000 acre-feet per year of sewage, of acceptable quality, passes through the Whittier Narrows area. Hence, there is considerable opportunity for expanding the reclamation activity at this location.

SENATOR DOLWIG: What do you mean by "acceptable quality"?

MR. BRUINGTON: Well, the many measures of water, all of which have to be met for the water to be usable for the various purposes, total dissolved solids, the chloride sulphates,

bacteriological quality after it is treated, many things of that nature.

SENATOR DOLWIG: Thank you.

MR. BRUINGTON: The second method of ground water replenishment; i.e., by injection through wells, involves purification of waste water to the degree that a public health hazard will not be created and that physical clogging of the recharge well will not exceed economical limits of well operation and rehabilitation. The need for considering this more expensive method of waste water reclamation can best be explained by a momentary diversion from the subject. Serious sea water intrusion into the ground basins along the coastline of Los Angeles County has been in evidence for many years. The planning and construction of facilities to create a fresh water barrier against this intrusion by creating an underground pressure dam is well underway. The present barrier development is based upon using Colorado River water, and will require about 50,000 acre-feet per year. Based on Metropolitan Water District estimates of the quantity of Colorado River water available for ground water replenishment in Los Angeles County, it will be necessary to curtail barrier operations after 1968 unless a supplemental water supply is developed.

The Hyperion Treatment Plant of the City of Los Angeles is strategically located within the limits of the largest barrier project, in the vicinity of El Segundo. It treats 265 million gallons per day of sewage, of which about 100 million gallons per day (about 110,000 acre-feet per year) receives a second stage of treatment before it is discharged to the ocean. The

water resulting from the second stage treatment is of a relatively high quality.

Tests were conducted during the 1955-58 period to determine if the high quality effluent from the Hyperion Plant could be given additional purification treatment so that it could be injected through recharge wells into underground formations of sands and gravels. Because a number of basic changes occurred in plant operations and nearby land development, it was not possible to draw definite conclusions from the earlier tests. However, the tests that could be made strongly indicated that with proper treatment the purified water could be used for injection purposes.

The tests at the Hyperion Treatment Plant have been renewed with the specific aim of determining if a rapid-sand filter or a diatomaceous earth filter can be used to provide additional treatment which is practical --

SENATOR COBEY: What does diatomaceous mean?

MR. BRUINGTON: The use of those two terms, "rapid-sand filter or a diatomaceous filter" mean proprietary devices. Both of them are high rate filter methods which use a small amount of land. In the particular instance of the diatomaceous earth filter, it is the use of diatomaceous earth as a mat through which the water is filtered, and it is a good filter.

The tests at the Hyperion Treatment Plant have been renewed with the specific aim of determining if a rapid-sand filter or a diatomaceous earth filter can be used to provide additional treatment which is practical from the standpoint of operational techniques, consistence of water quality, and costs.

Initially, facilities are being installed to pass plant effluent through a rapid-sand filter and inject it into a test recharge well. Provision is being made to chlorinate the water at any of several locations that might be desirable and to provide additional minor variations in treatment if it should be necessary. The amount of water to be treated and injected is relatively large so that test results should be typical of those which would be expected from a large-scale purification plant.

I have another set of photos. The photo being passed around now is an attempt to graphically show you what is the present result of operations with the rapid-sand filter. The attempt was to show in this little waterfall that the water is sparkling clear, that it contains very little that you could identify as being of a source from the sewage treatment plant. Also, once we accept the idea that this is a sparkling clear effluent and that it represents a product that could readily be used, then we should also call attention to the small layer of suds into which it is falling. This, of course, is the detergent problem. Any time you drop the water more than six inches that is what happens.

The distance of travel and the fate of some of the constituents of the water as it travels in underground, water-bearing formations are presently a matter of concern to public health agencies. In a parallel effort to obtain information on this problem, the California Institute of Technology in Pasadena has obtained a grant from the United States Public Health Service to undertake laboratorystudies. These laboratory studies will simulate the field conditions at the Hyperion Treatment Plant

location. By correlating data obtained from a number of sampling wells at the field location with similar data obtained under more controlled conditions in the laboratory, it is expected that conclusive criteria can be developed for purifying the water before injection underground.

SENATOR CHRISTENSEN: In connection with the actual injection into the wells, is that put in under pressure?

MR. BRUNINGTON: A minor pressure. In comparison, for example, to what is used in the oil industry, our pressures are negligible. It is a matter of perhaps tens of feet. The limit to the injection under pressure is the fact that the whole process depends upon the structural integrity of an overlying layer of impermeable materials, and generally speaking, these are not very good structurally, so we can't push very hard on it.

SENATOR CHRISTENSEN: Is it artificially induced pressure of some surface plant of some kind?

MR. BRUINGTON: Yes, in most locations where we have operated the ground surface has been 50 or 100 feet above sea level so we used the head of the water on the surface of the ground.

SENATOR CHRISTENSEN: There is no mechanical pressure?

MR. BRUINGTON: The only mechanical thing that might occur in some locations near sea level, we might use the pressure in the water of the pipeline similar to the way the pressure would be in your house, for example.

About the only additional treatment we give the water now over what you normally would expect is that we found it necessary to chlorinate the water more highly than is necessary

for just distributing water to homes. This is because there are live forms that have been dormant in the sand and gravel for tens of hundreds of thousands of years waiting for an opportunity to grow, and when we inject the water which contains oxygen and which, in spite of all of our efforts, includes some foods, these live forms will grow rapidly and clog the pores. We prevent their growth in the immediate vicinity of the recharge well by high chlorination. They undoubtedly grow away from the well. They are not harmful. They are a natural growth in the formation, and in some instances are probably helpful.

SENATOR CHRISTENSEN: Thank you.

MR. BRUINGTON: One of the conclusions of the 1955-58 tests was the need for revision of the so-called sewer well law (Section 4458 of the State's Health and Safety Code), which prevented the discharge of any water into a well reaching ground water, if the water was of sewage origin. Amendments to this section of the code, which will allow such discharge following thorough purification, were enacted by the legislature in the 1961 session. There is now provision for control of such discharge by the Regional Water Pollution Control Boards and the State Department of Public Health. The assistance of your committee, and other members of the Legislature, in providing a system for allowing controlled injection of reclaimed waste water is appreciated. It gives us a springboard from which to land our activities. As operations grow in the reclamation field, it is likely further problems will arise and be brought to your attention.

To summarize, it may be said that Southern California

is looking to all practical sources for its future water supply. The reclamation and reuse of waste water can provide a significant portion of future water supplies providing it is carefully planned and executed to protect public health and to prevent the buildup of excessive amounts of dissolved salts in the ground water basins.

CHAIRMAN TEALE: Mr. Bruington, we wish to thank you for the effort you made in the preparation of this paper. First, I would like to refer to your comments on page 2 where you say "at very low costs". What did you say that was?

MR. BRUINGTON: I didn't say because I didn't know.

CHAIRMAN TEALE: Do you have any idea what the cost range would be?

MR. BRUINGTON: Yes, I would judge it would be on the order of $5 an acre-foot. You understand, of course, this is possible because the plant facilities that are being used were in a sense abandoned from their previous use.

CHAIRMAN TEALE: I remember you talking about the total cost of the treatment, or are you talking of the cost in excess of what you normally give your sewage? I think we have to assume you have some sewage to dispose of first, is that right?

MR. BRUINGTON: Well, you see, in this instance the full capacity of these small plants is being used high up in the drainage area. The amounts of sewage that can't be treated at these plants then is diverted on down the system to the large treatment facility that the county sanitation district --

CHAIRMAN TEALE: Then, what you are talking about is a sewage that already has primary treatment?

MR. BRUINGTON: No, sir, not in this instance. The complete sewage treatment process is completed at each of these small plants before the water is discharged on to the ground or to the irrigator, but I would caution you not to interpret my comments as suggesting this is a typical water reclamation activity. It is simply making use of a facility that existed and developing it into a waste water reclamation activity. Perhaps the Whittier Narrows operation will be more typical because the plant is being built for this prime purpose and there will be some credit to the costs of treatment at that location for savings in cost at the treatment facilities downstream, the sewage treatment facility that would normally be operated downstream. Did I make myself clear?

CHAIRMAN TEALE: I think you did. In other words, you are picking up domestic sewage and treating it and you think the cost would be in the neighborhood of $5 or $7 a foot to make it suitable for injection or settlement?

MR. BRUINGTON: Let's make this clear, now. I believe that the $5 to $7 per acre-foot cost is the cost of those small treatment facilities in Pomona and Azusa and at the Whittier Narrows location the water replenishment district has agreed to pay $12.75 for the water delivered from the plant which is spread. The difference between the $12.75 and the figure I quoted here of $20 an acre-foot includes the cost of spreading the water and also includes consideration of the interest cost, that is, normal financing costs. This plant in that respect is not completely normal.

CHAIRMAN TEALE: Do you know what the West Basin group

are paying for injection water now?

MR. BRUINGTON: At the present time they are buying softened Colorado River water which is not necessary but is the only supply available. The cost is $20.75 an acre-foot.

CHAIRMAN TEALE: Now, we heard a lot about this West Basin and Central Basin in Riverside a couple of years ago. I was under the impression at that time that they had pretty well worked out the direction and extent of water flows from their injection wells and from their pumping wells.

MR. BRUINGTON: I believe you could say that pretty well.

CHAIRMAN TEALE: If that is true, then wouldn't it be possible to utilize your reclaimed sewage as a barrier and keep your spread by utilizing your softened Colorado River water as a recharge to be pumped out again?

MR. BRUINGTON: Yes, sir, we agree that it should be practical to use the reclaimed waste waters for the barrier project. The tests that are under way at Hyperion now are directed towards working out the details of control treatment systems and things of that nature that will be required in order to use the water. This needs a lot of attention from the public health standpoint.

CHAIRMAN TEALE: Another thing is the amount of water required to maintain your barrier. Does that have a relationship to the amount that is utilized out of the underground basin or is there a relationship between the amount used and the amount necessary to maintain the barrier?

MR. BRUINGTON: Yes, sir, a direct relationship. The

amount of water required to be injected along the coastline is equivalent to the amount of water that would have passed that location from the sea if the barrier had not been placed there. The amount that would have passed that location from the sea is the amount that would have been drawn into the ground water basin by the pumping. So the less pumping there is the less barrier demand there will be. The more pumping, the more barrier demand.

CHAIRMAN TEALE: So then if you had a suitable surface supply, the amount required for your barrier and the amount of mixing up barrier water with your basin water would be greatly reduced?

MR. BRUINGTON: We are getting into a realm, of course, away from waste water reclamation.

CHAIRMAN TEALE: I'm looking into the use of your reclaimed water. You have to have a use for it or there is no use reclaiming it.

MR. BRUINGTON: The justification for preserving the integrity of the ground water basin is the need for the storage capacity for peak demands, for emergency demands, or day-to-day uses in the ground water basins. In order to make the most use of these basins we must be able to fill them and empty them, and in order to do that in the basins near the coastline we have to have some measure of protection through these barrier projects or other means of preventing sea water intrusion to hold the sea back.

CHAIRMAN TEALE: I would like to turn to page 4 of your presentation, the first paragraph where you say the Hyperion Treatment Plant treats 265 million gallons a day of

sewage with about 100 million gallons a day receiving a second-stage treatment before it is discharged to the ocean. Why the separation? Why the difference in the classification of sewage and why the extent of treatment of the 100 million gallons?

MR. BRUINGTON: Again, this results from the construction of additional facilities, the enlargement of the plant. When the original Hyperion Plant was constructed in the late forties and early fifties, it had a smaller capacity than it has now. They used a treatment process which involved both primary treatment and secondary treatment. When the capacity of that plant was exceeded by the growth of the area, they enlarged the plant, but when it was enlarged, the enlargement did not include additional secondary facilities. It included a longer ocean outfall for disposal of the primarily treated water. The reason the secondarily treated water is available now is because in the modified system, the City is using the new facilities and in the old facilities they are using their new ocean outfalls and their old ocean outfalls. The result, however, is very good for waste water reclamation interests because here is a water which is of relatively good quality which is available if the city policies allow them.

CHAIRMAN TEALE: Is it desirable from the standpoint of public health that the water be given the secondary treatment before it is discharged into the ocean or is that dependent entirely upon the distance of the discharges out from the land?

MR. BRUINGTON: You are completely out of my field, Senator.

CHAIRMAN TEALE: I would like to know from somebody.

Are there any questions from Members of the Committee?

SENATOR DOLWIG: I have a question. I am going to follow through the questions asked by Senator Teale. Do I understand that the 265 million gallons is your primary treatment and the secondary treatment then goes out to the ocean, all of it?

MR. BRUINGTON: That is correct, sir.

SENATOR DOLWIG: All of it?

MR. BRUINGTON: All of it now goes to the ocean, yes, sir.

SENATOR DOLWIG: If the tests that are now being made in the other areas, if they are successful, will you then be able to reclaim this 265,000?

MR. BRUINGTON: Probably not all of it.

SENATOR DOLWIG: If you have the facilities and so forth?

MR. BRUINGTON: Let's say in the present degree of our thinking we probably would not economically be able to reclaim all of the 265 million gallons a day because there are certain parts of the truck sewer system of Los Angeles which collect industrial wastes or have infiltration of brines into the sewers. Those waters are being segregated now so that, let's call them bad waters, are being given primary treatment and sent directly to the ocean, and the so-called good waters are the ones that are getting the secondary treatment and are available for reclamation.

SENATOR DOLWIG: What would be your estimate as to the amount of the good water either in acre-feet or gallons, just roughly?

MR. BRUINGTON: My judgment at the moment is so colored by the fact that I know how the Hyperion Treatment Plant physically is set up and the amount of dollars it would take to change that setup, that I --

SENATOR DOLWIG: Again let me ask a question, if you had sufficient facilities, how much good water would you then be able to reclaim?

MR. BRUINGTON: Purely a guess, I would say perhaps 200 million gallons a day.

SENATOR DOLWIG: I have a further question here as far as your barriers are concerned. You indicated it would take about 50,000 acre-feet per year. Now, is this water purchased by the City of Los Angeles from Colorado River or who purchases the water?

MR. BRUINGTON: The barrier project that we are speaking of we call the West Coast Basin Barrier Project for identification, protects the West Coast Basin from sea water intrusion from the Santa Monica Bay. That area is made up primarily of cities other than the City of Los Angeles, so other means of arranging for purchase were necessary. For a while the purchase of water used in the barrier was done by means of the temporary zones of the flood control district. This is not a permanent financing arrangement and it didn't warrant the capital outlay for barrier project facilities, so the Central and West Basin Replenishment District has now taken over the responsibility for purchase of this water and plans to continue to do that.

SENATOR DOLWIG: And they purchase it and then insofar

as your underground supply is concerned, people that use the underground supply then pay for that, is that correct?

MR. BRUINGTON: That is correct, the Water Replenishment District funds come from pumping assessments.

SENATOR DOLWIG: And these districts are reimbursed or get their money back through that means?

MR. BRUINGTON: There is no reimbursement aspect to the barrier project. If I understand your question, the only reimbursement that we are talking about was with regard to the Whittier Narrows waste water reclamation project. The people who pay the bill, who pay for the pumping assessment and thereby pay for the water that goes into the barrier project have the facilities and the right to pump the water back out of the West Coast Basin, so in a sense they are paying for their water in that way.

SENATOR DOLWIG: But the flood control district would not be reimbursed for the 50,000 acre-feet per year?

MR. BRUINGTON: Well, we don't buy the water. The replenishment district buys it and delivers it to us for putting in the wells. We don't handle the finances at all.

SENATOR DOLWIG: One further question. I'm going back to a question I asked yesterday and that is what is the status insofar as the water rights to the underground waters are concerned after they have been reclaimed and put in your underground basin? Do you have any comments on that?

MR. BRUINGTON: Well, I would be glad to tell you what I know about it. It is still rather a complicated thing as far as the coastal part of the county is concerned. The West Coast

Basin being the farthest from the supply felt the pinch the soonest and started a ground water basin adjudication. I believe it was in 1946 or 1947. They are virtually completed with their adjudication. The pumping rights are set, virtually set.

The Central Basin being the next step in the chain towards the mountains where the water comes from, began to feel the pinch a few years ago and filed a suit of some type against the San Gabriel Valley people for saying that there was not enough water arriving at Whittier Narrows, the dividing point between San Gabriel Valley and the lower area. This suit has progressed to the point that there is a negotiated statement of principles which the two parties hope to use as a basis of agreement as to the split of water at Whittier Narrows. At the same time, this does not establish individual pumping rights in the Central Basin. The Central Basin water interests are studying the possibility of filing a suit within the basin to determine these water rights. They have not decided for sure to do this.

The San Gabriel Valley being closest to the supply, they haven't progressed any farther than just answering their responsibilities in the suit filed by the Central Basin.

SENATOR DOLWIG: Do you think that these are problems which would perhaps be more adequately settled by legislation?

MR. BRUINGTON: I don't feel that I am adequately informed in this matter.

SENATOR DOLWIG: Just your own opinion.

MR. BRUINGTON: If I may, sir, I would defer.

SENATOR DOLWIG: All right. Thank you.

SENATOR COBEY: In regard to the San Gabriel Valley, they are still under a watermaster, aren't they, the Raymond Basin?

MR. BRUINGTON: The Raymond Basin represents just a fifth of the area of the San Gabriel Valley.

SENATOR COBEY: They are the only part of the valley at the present time that are under a watermaster?

MR. BRUINGTON: That is right.

SENATOR COBEY: But under that watermaster operation within the Raymond Basin the rights are adjudicated, as I recall?

MR. BRUINGTON: Yes, sir.

SENATOR COBEY: The pumping rights?

MR. BRUINGTON: Yes, sir.

SENATOR COBEY: Now, with respect to the operation of the Azusa and Pomona Reclamation Plants, as I understand it, the figure that you gave of $5 to $7 an acre-foot represents purely operational costs. There is no capital outlay involved there at all. Now, is the cost of treatment for that purpose any greater than the ordinary cost for treatment of sewage? I think that is what the Chairman was getting at and I didn't quite understand your answer to that.

MR. BRUINGTON: Perhaps I didn't understand that is what the question meant. I would say that there are perhaps two contradictory items working on costs as far as water reclamation plants are concerned. On the one hand, if there are downstream sewers available, the solids that are removed from the water do not have to be treated at the waste water reclamation plant location. Therefore, they can be diverted for

treatment downstream. This reduces the cost. On the other hand, a well-integrated water reclamation system probably should have a number of small plants spotted around as high up on the watershed as it is proper as far as dissolved salts are concerned and as far as the supply of the sewage is concerned. The operation of smaller plants, of course, involves higher unit costs. I'm not sure where the balance would be. Generally speaking, it would tend to be less than the sewage treatment cost, I would believe.

SENATOR COBEY: In any event, as I gather, you almost have to have standby, shall we say, sewage disposal facilities in case there is any sort of breakdown of a reclamation plant?

MR. BRUINGTON: The Los Angeles County Sanitation District people, the ones who handle the operation of this type of thing, have developed a pretty firm policy that this is the way they intend to operate. They have a system which perhaps is perhaps amenable to this because they have many trunks. They serve many areas. They can put in many small plants and if something goes wrong at one plant, they will have adequate downstream capacity.

SENATOR COBEY: Now, did I understand you correctly that so far as your barrier basin protection is concerned at the present time, that is coming from the Colorado River, and because they have no other source they are using the treated Colorado River water and that is running around $20 an acre-foot?

MR. BRUINGTON: $20.75.

SENATOR COBEY: But if they use this reclaimed water from the Whittier Narrows Project, the purchase price of the

water itself would only be $12.75 and to that must be added the spreading cost and financing cost?

MR. BRUINGTON: I perhaps didn't adequately explain the geographical significance of these things. I was telling you Whittier Narrows is considerably removed from the location of the barrier project and at least at the present point of planning we don't draw any correlation between the two projects. It is too far away, too many dollars apart. Whittier Narrows waste water reclamation project will deliver water for spreading in the spreading areas pictured in the photos I showed you.

SENATOR COBEY: I'm sorry, I misspoke myself. Then Whittier Narrows, of course, that water would be used merely for basin replenishment?

MR. BRUINGTON: Yes, sir.

SENATOR COBEY: And will not be used at all for the barrier?

MR. BRUINGTON: That is right.

SENATOR COBEY: The barrier water will come entirely from your Hyperion Plant?

MR. BRUINGTON: As we see it now, that is correct.

SENATOR COBEY: Treatment plant. And of course, as I see it, and as you probably already said, one of the great advantages is that being located down there by the ocean, in the event that you don't need it for barrier protection, you have an easy and economical disposal.

MR. BRUINGTON: That is correct. You might have noticed also that I did not establish a price on the more highly purified water from Hyperion Treatment Plant because we don't

know.

SENATOR COBEY: You don't yet know how much that is going to run?

MR. BRUINGTON: No. It would be on the order of the cost of the treated Colorado River water, we believe, so there is no particular economic advantage at the moment.

SENATOR COBEY: There is no particular saving so far as quality of water in terms of mixing it with your ground water, I assume. Even though this is a barrier, there is a certain mixture with the ground water basin. How does the Colorado River water and your reclaimed water compare in quality?

MR. BRUINGTON: Very similar.

SENATOR COBEY: I thought so.

CHAIRMAN TEALE: Senator Murdy.

SENATOR MURDY: Did I understand you to say the adjudication of the water rights of the West Basin is completed?

MR. BRUINGTON: Yes, it is virtually completed. It isn't absolutely.

SENATOR MURDY: What was the amount per acre?

MR. BRUINGTON: It was not established in that way, Senator. It was based upon the pumping rights of the individual pumpers developed by their records in the late forties, I believe it was, and as I recall, the West Basin was found by the watermaster to have a safe yield of 30,000 acre-feet, but I believe the pumping that is being allowed in the West Basin, even though the basin is completely adjudicated, is more on the order of 60,000 acre-feet, recognizing that there is an overdraft still continuing and that it will be solved by the

barrier project and other replenishment means.

SENATOR COBEY: Didn't you use exactly the same system that was used in the Raymond Basin, that the highest use over any five-year period in the past established the amount?

MR. BRUINGTON: I don't know. I think so.

SENATOR COBEY: That is my recollection.

SENATOR MURDY: I have one more question. If you, the county or some agency has spent a lot of money recharging the underground basin, how do you arrive at the amount with your adjudicated rights after the county has spent the amount of money to bring water into the district?

MR. BRUINGTON: It is a good question. I don't believe the court has been faced with it yet because the West Basin did not have such replenishment when the rights were being determined.

SENATOR MURDY: You can't adjudicate artificial rights, can you?

MR. BRUINGTON: I'm simply not informed, sir.

SENATOR COBEY: Mr. Chairman, I wonder whether this committee could have the records, and by records I mean the records of the final adjudication on the Raymond Basin and the West Coast Basin and also a statement of the present status of the Central Basin adjudication. Whether this could be developed for us?

CHAIRMAN TEALE: We'll instruct Mr. Lapham to look for it. He is pretty competent.

SENATOR COBEY: It is all a matter of public record.

CHAIRMAN TEALE: If he can find it, it will be made

available to the committee members. Senator Slattery.

SENATOR SLATTERY: We'll talk about the Whittier Narrows Project. This $10 per acre-foot figure, that is for spreading the water in the percolation areas?

MR. BRUINGTON: Yes.

SENATOR SLATTERY: What would be the comparable figure to say delivering it to a reservoir or canalside or wherever? I mean anyplace you want to take the water to get this water that you have percolated back into there?

MR. BRUINGTON: I believe that a reasonable estimated cost for the area we are speaking of would be a cost of $5 an acre-foot for the pumping facilities required to take it out of the ground and place it into a distribution reservoir.

SENATOR SLATTERY: In other words, it would be about $25?

MR. BRUINGTON: Yes.

SENATOR SLATTERY: Then, how does that compare cost-wise with your Colorado River Project?

MR. BRUINGTON: The Colorado River water that is delivered for domestic purposes, if it is softened, now costs $23.75, I believe. If it is unsoftened, rather, untreated, it is $15.75. The Metropolitan Water District has a scale of prices which covers ground water replenishment. It covers domestic uses and it is changing 75 cents per acre-foot every year and there are diversions for treatment, and my memory may be wrong, but I believe those are about right.

SENATOR SLATTERY: Generally, they would be comparable in price, fairly comparable?

MR. BRUINGTON: Yes.

SENATOR SLATTERY: Do you anticipate that Feather River water would be any cheaper?

MR. BRUINGTON: No, sir.

SENATOR SLATTERY: It will be more expensive, is that not true?

MR. BRUINGTON: Yes, sir.

SENATOR SLATTERY: Pretty definite.

MR. BRUINGTON: In our areas, yes, sir.

CHAIRMAN TEALE: I would like to interrupt and ask a question. You talk about the cost of Colorado River water being $17 to $25 an acre-foot. I'm sorry, I was talking when you were talking. What is the total cost of Colorado River water when you include the tax cost as well as the water cost charged to the individual?

MR. BRUINGTON: I don't know. I have heard various talks and I believe the officials of the Metropolitan Water District now indicate that it is less than $40 an acre-foot, but I don't know how much less.

CHAIRMAN TEALE: That is approximately twice the reclaimed water?

MR. BRUINGTON: Yes.

SENATOR SLATTERY: As you have increased needs for water in your area, your service area, and more water is delivered out of the Colorado River or eventually out of the Feather River Project, that will then add to the amount of this reclaimable water? I mean water very seldom is actually lost, isn't that correct?

MR. BRUINGTON: That is correct, sir.

SENATOR SLATTERY: So if you get another million acre-feet or two million acre-feet or whatever it might be, you are going to have somewhat of a similar amount of water available for reclaiming?

MR. BRUINGTON: There will be increments available for that, yes, sir. We will, however, be getting new problems. As the quality of water deteriorates, which seems inevitable, the amount of sewage that we can use will be reduced because in each use of sewage there is a certain incremental addition to the dissolved salts. Once we reach a limit of those, a public health limit, then the water will have to be disposed of.

SENATOR SLATTERY: But if you just get one reuse, you have doubled your water supply?

MR. BRUINGTON: That is correct, if we did. We have industrial waste disposal. We have a physical location of the trunk sewer system, treatment plant systems. All these things have to be considered with you come up with the economic problem.

SENATOR SLATTERY: I would like to return now to page 1 where you say that this reclamation of waste water is not a substitute nor even a competitor with supplies planned to be imported from northern California. In other words, as the imported water is brought into your area and with better means of reclaiming, which I gather from your paper here is in the offing, you are certainly working for better means of reclaiming water, and it would appear that there would be no end, then, to the amount of water that you would eventually be able to use both from imported water and from reclaimed water which increases

as does your imported water.

MR. BRUINGTON: I think the thing that I haven't developed sufficiently to answer that question is the fact that there are two things about sewage that make it undesirable for use, make it impractical for use. One is the organic content of the water. The other is the dissolved salts nature of the water. The treatment that I spoke of that is being worked on is in the field of the removal of organic matter from the sewage. The removal of the organic matter means that once it is done the water is stable. It won't go stale on you. It won't start smelling. It will be good water for use, but the dissolved salts that the water contains cannot be removed by these methods. When we start talking about the removal of the dissolved salts, we are in a sense talking about sea water conversion. It is the same type of thing. It isn't exactly the same because the concentration of dissolved salts is less, but once it reaches the limit of public health use, the limit of desirable use for water purposes, then it costs to reclaim it more.

SENATOR SLATTERY: On percolation, what have you found as to the distance from the recharging areas -- first, I would ask how far away would you have wells to reclaim this water? How far distance from the recharging area; in other words, how much percolation would you ordinarily have?

MR. BRUINGTON: Well, there are some wells that will be within, perhaps, several hundred yards of the reclaimed water. The water potentially can reach 15 or 20 miles. Is that what you meant?

SENATOR SLATTERY: I wanted to ask you what difference

do you find in the quality of the water, say 10 miles away and 500 feet?

MR. BRUINGTON: We haven't had that much experience, Senator. It takes years for the water to travel that far. The water close by the spreading ground, we have spread large amounts of Colorado River water, over 500,000 acre-feet in these two grounds that you have seen here. We can readily identify this Colorado River water in the ground water body because of the dissolved salts content. It retains the same relationship between the salt, the chlorides and the sulphates and the other things, so that you can identify the water. We found easy identity within an mile of the spreading ground. We found less sure identity perhaps out three or four miles. That is as far as we found it and we have been spreading since 1953.

SENATOR SLATTERY: Three or four miles is as far as you have made an experiment?

MR. BRUINGTON: As far as we can reasonably identify it. We have tested farther.

SENATOR SLATTERY: At these greater distances is the quality better?

MR. BRUINGTON: Yes, it is better because there has been more mixing. The thing I perhaps should make clear is that there is no way in the underground that the dissolved salts content can be exchanged through chemical action or anything of that nature. The water that arrives in the ground will have the same dissolved salt content when it moves through the ground with certain very minor exceptions.

SENATOR SLATTERY: Except by dilution?

MR. BRUINGTON: Except by dilution, yes.

SENATOR COBEY: The Colorado River water at the present time is running what, 700 to a thousand parts per million salts?

MR. BRUINGTON: 700 to 800 I think would be a good area to put it in.

SENATOR COBEY: So what you have been saying is that you start with a fairly high salt content and there is no way that that salt content can be removed unless you want to go through a desalting process?

MR. BRUINGTON: That is right.

SENATOR COBEY: And the only thing you can do is mix it with less salty water?

MR. BRUINGTON: Right.

SENATOR COBEY: Now, with respect to the limits of reclamation of sewage water, as I get it, at the present time your thinking is that it is domestic sewage that is essentially the reclaimable part of sewage?

MR. BRUINGTON: Yes, sir.

SENATOR COBEY: When you get into industrial wastes, why there are components in that sewage that make it practically irreclaimable, at least economically at the present time.

MR. BRUINGTON: That is right, sir.

SENATOR COBEY: And I don't know how much agricultural experience you have down there, but you have some of the problems with agriculture water that has been used quite a few times. That's all.

SENATOR CHRISTENSEN: We discussed here certain figures, $20, $12.75, and there is a minimum amount that is to be treated?

MR. BRUINGTON: Yes, a fairly large volume.

SENATOR CHRISTENSEN: What is that minimum amount that would not receive any treatment?

MR. BRUINGTON: Well, we feel the $20 that was quoted as being the cost of Whittier Narrows Project can be accomplished with the 10,000 acre-feet per year that probably will be produced by the plant, estimating as we did that the cost at Hyperion might run $20 an acre-foot and would require a plant of probably 20,000 acre-feet a year at least in order to keep the operation costs down.

SENATOR CHRISTENSEN: Is there any premium, if that is the right word, that we might anticipate from an increased amount of water being reclaimed? In other words, are these costs reasonably constant or will they decrease as the amount that is reclaimed increases?

MR. BRUINGTON: I believe the unit cost would tend to decrease.

SENATOR CHRISTENSEN: Decrease?

MR. BRUINGTON: Yes, perhaps not significantly, but some.

SENATOR CHRISTENSEN: Is there any experience that you had, I mean, to justify that?

MR. BRUINGTON: No, perhaps sewage treatment people familiar with sewage treatment plant operations could shed some light on it, but I have no such experience.

SENATOR CHRISTENSEN: Would you form an estimate of

these more specifically than just the fact it would decrease; to what degree would it decrease?

MR. BRUINGTON: I would say only in a minor way, sir. No, I wouldn't think it would decrease 25 percent.

SENATOR CHRISTENSEN: One other question. Perhaps you have answered it, and that is with reference to page 2 where we discuss the percolation of the treated water into the ground water basin. Is there any reason to believe that this will contaminate the percolation bed itself where they will no longer be as efficient?

MR. BRUINGTON: These tests that I referred to in Whittier and Azusa and also some tests run at Hyperion indicated to us that we can continue to use spreading areas providing we give them rest periods, providing we make certain that air is driven into the soil as well as water, so that the solid matter that is still in the water and is driven down into the soils can be taken out by bacteria in the presence of oxygen.

SENATOR CHRISTENSEN: Is there any estimate you have formed as to the cost of keeping these percolation beds in the condition where they will be efficient?

MR. BRUINGTON: We have developed the policy in the flood control district that the spreading grounds that we have in existence are justified, and much of their cost is written off against the conservation of local storm waters. Consequently, when the spreading of either Colorado River water or this reclaimed waste water enters the picture, we don't include in those costs any amortization of the capital facilities nor costs of right-of-way or any of those things, so leaving those

out of the picture, we presently estimate that our costs for spreading the water from Whittier Narrows will be on the order of $2.50 an acre-foot. This will include moving the water around, perhaps scarifying the basin to allow the air to get down better and things of that nature.

SENATOR CHRISTENSEN: In the event, then, you should run into this problem that we were discussing of contamination of the percolating beds themselves, that would be another factor of that cost?

MR. BRUINGTON: Very definitely. We don't think there is much opportunity that that will happen. We plan to operate in such a way that it will not happen, but if it should, it would involve considerable additional cost to remove that material or to clean it some other way.

SENATOR CHRISTENSEN: Thank you.

SENATOR DOLWIG: I would like to ask some questions on the underground barriers. Does construction of the underground barriers prevent salt water intrusion in the underground basin? Is this a new concept or an old concept?

MR. BRUINGTON: Well, relatively new. I would say that to my knowledge the work on it began in the late 1940's and since sea water intrusion progressed the farthest in the West Coast Basin of Los Angeles County, the most activity that I know of has occurred there, and of the five systems that are available to prevent sea water intrusion, the barrier project concept, the fresh water barrier concept seems to be the one most applicable to the areas along the Los Angeles County coastline. It is expensive.

SENATOR DOLWIG: How far have you proceeded as far as the construction of a fresh water barrier is concerned?

MR. BRUINGTON: The West Coast Basin barrier project will need to cover about 11 miles of this Santa Monica Bay coastline. The first facilities along the coastline were built in 1952 and 1953 with the money from a $750,000 appropriation from the Legislature for test purposes. That was passed in 1951. When the test was completed, those facilities covered about three-quarters of a mile in Manhattan Beach, which is essentially in the middle of the 11-mile reach. When the test was completed in 1954 the facilities were sold by the State to the flood control district and we have operated those continuously since and we have added a small amount or a small number of additional facilities, more on an experimental basis than anything else, so that at the present time about a mile and a half is being protected using about 7 cubic feet per second. In addition to that, the financing seems to be clearly indicated now for completion of the barrier project and within a few months we will be letting some major contracts for water distribution lines, for recharge wells, for observation wells and things of that nature. The Metropolitan Water District has installed -- well, I got a contradictory figure on this the other day, but I believe it is a $7 million line to bring water to near the coastline for these barrier project uses.

SENATOR DOLWIG: Do you feel that if there was an appropriation from the State to assist you in this project that this would give you answers quicker insofar as the feasibility of these barriers is concerned?

MR. BRUINGTON: There are three barrier projects being considered along the coastline in Los Angeles County. We feel there is no doubt about the feasibility of the West Coast Basin barrier project. We are presently studying the feasibility of the other two. However, studies of feasibility are about complete.

SENATOR DOLWIG: Do you feel that there is a statewide or a benefit or interest insofar as the fresh water barriers are concerned? I know I'm taking you outside of your own field right now, but the reason for my questioning is that there was legislation on this subject in the last session and there wasn't enough time and I would just like to get your opinion as to whether the same problem does not exist in other areas in the State and if it does whether there isn't a statewide interest to warrant a State appropriation to hasten these projects?

MR. BRUINGTON: Senator, I'm not authorized by the Board of Supervisors of Los Angeles County to answer policy questions like that. I'll defer.

SENATOR DOLWIG: All right, thank you.

CHAIRMAN TEALE: Mr. O'Connell, do you have a question?

MR. O CONNELL: Yes, I would like to go back to the subject of concentrations of dissolved solids with reuse and ask your opinion as to the number of reuses that might be possible with the several different water supplies that are generally available in southern California. Let me start by assuming that the Colorado River supply might be reused once or something of that sort. What would your opinion be as to the number of times that the Owens River water supply, the underground

water supply and the projected Feather River water supply could be reused in comparison with the one reuse of the Metropolitan water looking at it strictly from the standpoint of dissolved solids.

MR. BRUINGTON: I'm hesitating because there is a rule of thumb which one can apply to dissolved solids, but I don't think that the answer is as simple as applying the rule of thumb. With the preamble that I wouldn't care to have the rule of thumb applied directly and conclusions drawn directly from it, I can say that the rule of thumb is that one use of water will involve the addition of about 300 parts per million in total dissolved solids. The Colorado River water, then, is marginal as far as a reuse is concerned, because 1,000 parts is generally used as a limit. Native ground water in coastal Los Angeles County varies from probably 300 parts to over a thousand parts. I don't know the total dissolved solids of Owens River water and I don't know what the total dissolved salts will be of water delivered from the Delta.

MR. O CONNELL: Would it be fair to assume that Owens River probably runs 150 parts per million?

MR. BRUINGTON: I just can't recall, sir.

MR. O CONNELL: But it is in that order?

MR. BRUINGTON: It is low.

MR. O CONNELL: It is low. Now, so that there would be a greater reuse potentiality considering reuse of Owens River water and if the quality commitments that I think everybody is looking forward to on Delta water are met, that would have a greater potentiality for reuse than the Colorado River

water?

MR. BRUINGTON: Yes.

MR. O CONNELL: Now, there is one other question, Mr. Chairman, I would like to get into and maybe I misunderstood you. I understood you to say that you pay Azusa and Whittier $12.50 an acre-foot for their sewage plant effluent.

MR. BRUINGTON: No.

MR. O CONNELL: This is probably where the problem comes.

MR. BRUINGTON: The mention of Whittier and Azusa was in reference to tests that were made in 1948 and 1949 on facilities that existed at that time. Those facilities no longer exist. They have been integrated into the system of the County Sanitation Districts. I did say that at Azusa and in Pomona that facilities of this nature were integrated into the county sanitation districts and that I estimated the cost of treatment at those two locations might be $5 an acre-foot. These are costs which the County Sanitation District is incurring in treating the water. There is no sale or reimbursement involved. This is simply a cost they are incurring. At the Whittier Narrows where the County Sanitation District is building this experiment plant, the water will be sold for $12.75 an acre-foot.

MR. O CONNELL: You are not reimbursing the communities that are discharging their sewage?

MR. BRUINGTON: No, sir, they are members of the County Sanitation District. They are paying their share of the bill.

MR. O CONNELL: What is the situation with respect to the use of Hyperion sewage. Are there any questions about the ownership of that water?

MR. BRUINGTON: Yes, sir.

MR. O CONNELL: What are those questions?

MR. BRUINGTON: The questions are that the treatment plant is operated by the City of Los Angeles. The projected uses that we have discussed today would be in areas outside of the City. It will be necessary for the City to decide what their policy will be on releasing these waters for the use of others.

MR. O CONNELL: Am I correct in my impression that the Department of Water and Power of the City of Los Angeles feels that they retain ownership in that water even though it is to the point where it is discharged in the ocean?

MR. BRUINGTON: I don't know what their present feelings in that line are. I know, as you know, that at one time they did say that.

CHAIRMAN TEALE: I don't think there are any further questions. I would like to thank you again for the effort you put into this presentation and I think I can on behalf of the committee commend you for your work that you are doing down there. I personally think that you are going a long ways toward solving the problem of stretching the water supply. Thank you again. Now, Members of the Committee, we are running a little behind. We have one other witness scheduled for this morning, Mr. Carozza, Director of Public Works of the City of Fresno. If he is here, I'll call him

at this time. We have had an offer of testimony from a very good friend of the committee, Mr. Harvey Banks. I would like to run the committee right through until we finish. I think we can do it by 12:30. Mr. Carozza.

MR. CAROZZA: I appreciate the opportunity to come before the group this morning. As you have indicated, my name is Mike J. Carozza. Through your communication you asked that I review the program that the City of Fresno is conducting in the reclamation of water. If I might read this statement first, I would appreciate it and then if there are any questions I would be happy to answer.

Few cities have actively investigated water reclamation programs. Many cities, however, have backed into reclamation programs of fairly large size. For this reason may I thank you gentlemen for this opportunity to explain to you the unique situation of the City of Fresno in regard to water reclamation. Fresno is typical of a number of San Joaquin Valley communities who actually contribute large amounts of water to the underground water system.

Fresno is a community of 140,000 people located in the heart of the rich farming and agricultural San Joaquin Valley. This 32-square-mile community captures in its storm drainage and sewer system 31,000 acre-feet of water annually. The flow of water reaches two peaks. The first arrives with the winter rains and the second is a direct result of the high temperatures in the summer and the need for evaporative coolers. Fresno's Water Division operates on a flat rate without water meters. This contributes to a per capita consumption rate which is nearly six

times the national average, 340 gallons per day per capita yearly average, peaking to 800 gallons per day per capita. During this last summer 95 million gallons of water per day were pumped, peaking to 120 million gallons on the hottest day. The Fresno Water Division pumped a total of 60,000 acre-feet of water during the last twelve months; of this 31,000 acre-feet reached the sewer system. During last year's unusually dry winter 500 acre-feet of storm water were collected in Fresno's sewer system.

Why, then, does this make Fresno unique in the field of water reclamation? Most cities throughout the United States dispose of their sewage water by pumping it into rivers or by pumping it into the ocean where it is irretrievably lost. Fresno does not have any natural place to dispose its water and as a result disposes of its plant effluent in 1,500 acres of settling basins. Water is given primary treatment and then drained into 1,000 acres of ponds which contain from one to three feet of water throughout the year.

I would add that this process has been going on since the first sewage system which was installed in approximately 1890. At that time it was through the use of Emhoff tanks into a pond and now it is through a primary sewage treatment plant into the pond.

As the city enlarges, the amount of sewage flow is outgrowing the ponding areas available at the sewage treatment plant. To some extent the city has been able to increase percolation by 50 percent through subsoiling each holding bed every three years. As a result of continued growth, however, leases with neighboring farms have been negotiated and the actual

area in which Fresno can dispose of its sewer water has been doubled to 3,000 acres. The agreements with local farmers have been very popular since the flow of water available to the farmers is the greatest during the summer when the water is needed most. I'll add at this point, too, this type of operation is in complete compliance with the state health laws pertinent to the use of this type of water. The peak flow of storm water during the winters is used for reclaiming alkaline soils by leaching. During the history of the leasing agreements to the farmers, large areas of previously unproductive farmland have been turned into rich soil which supports crops of cotton, alfalfa, sugar beets, corn and almonds.

A second reason why Fresno is unique as a reclaimer of water has developed as a result of the formation of the Metropolitan Flood Control District. This storm drainage control agency has begun to build holding or ponding areas throughout the city. Thirteen basins have already been purchased which have a capacity of 120 acre-feet of water. Ultimately 49 holding basins are proposed which will accommodate storm water from a 70-square-mile area. These holding basins will capture an estimated 6,600 acre-feet of runoff water. Of this, 4,000 acre-feet will be percolated into the ground and the remaining 2,600 acre-feet will be channeled into irrigation canals.

City participation in a water reclamation program is a wide field for investigation. In many cases the costs of reclamation may be sizable. Regardless, two methods of encouraging cities to investigate water reclamation projects might be considered.

1. Allocation Credits. When water is allocated to various jurisdictions, credits are allowed for water returned to the ground water system by septic tanks and percolation in streambeds. If the water added to the ground water system through a water reclamation project was creditable, interest in such programs might increase. What I'm suggesting here is the possibility that there may be greater emphasis can be put on the value of reclamation. Another area that I do think there can be assistance on is through the federal grant.

Public Law 660 grants federal funds for construction of public works projects, including sewer systems. Such grants are awarded in part on the basis of applying the city's bonded indebtedness and need. It is suggested that communities actively participating in a water reclamation program be given some type of credit for this work toward receiving these federal grants.

Irrespective of the actions that may have to be taken by the City of Fresno, the topography of Fresno will dictate that we continue with a program of water reclamation. Through working with the farmers we have found that this cooperation can result with direct economic benefit to the farmers and also to the ultimate good of the community as a whole.

CHAIRMAN TEALE: Thank you very much, Mr. Carozza.

MR. CAROZZA: This has been brief, but if there are questions in regard to our operation, I'll be happy to answer them.

CHAIRMAN TEALE: It is very brief and concise and understandable. I have one question on the disposal of this water to the farmers. Is this on a free gratis basis or is the

farmer charged for the water that is delivered to him?

MR. CAROZZA: We have through negotiation worked out a free arrangement with the farmer. I say "free" to this extent. It is not truly free. The approximately 1,000 acres of beds that we retain our waters in can become less than what we need at certain times during the year so our arrangement with the farmer is that we not only give him water at no cost but for that privilege he provides for us an easement through his lands so that we can reach other lands, and further, he provides us the privilege of inundating his property in the event that we need more than the area that we are working within that is city-owned. So there is a little give and take on this one.

CHAIRMAN TEALE: He has to surrender a little bit.

MR. CAROZZA: There is no crop damage to the city in the event we have to inundate his lands because of a high storm period or something of that nature.

CHAIRMAN TEALE: The second question, I assume that when you talk about allocation credits you are anticipating that water will percolate into the underground and then be repumped by that area for reuse?

MR. CAROZZA: I think in our basin, you appreciate we haven't reached a point of adjudication of water, thank goodness. Maybe we can do it by agreement.

CHAIRMAN TEALE: You are pumping from the underground?

MR. CAROZZA: We are pumping from the underground now, right. In past adjudications we appreciate there have been credits given for the fact that water does return to the underground through irrigation or through septic tank, basins of this

nature. I'm suggesting that possibly more weight can be given in this direction to those people that are doing a prime job of reclamation.

CHAIRMAN TEALE: Senator Cobey.

SENATOR COBEY: Mr. Carozza, then so far as the sewage effluent that you made available for irrigation purposes, that is done on a contract basis to the farmers and there is no cash consideration, but the consideration is exchange of flowage easements?

MR. CAROZZA: Right. There is no cash consideration.

SENATOR COBEY: And no indemnity guarantee so far as liability for any damage by reason of these operations?

MR. CAROZZA: Right.

SENATOR COBEY: Now, secondly, as I recall the testimony in the hearing on the San Joaquin River before the State Water Rights Board which I participated in as an attorney, roughly 85 percent of the water for the City of Fresno well system is supplied by the Fresno Irrigation District through the Kings River diversions?

MR. CAROZZA: Well, I would answer that is their contention. I don't say we agree with them.

SENATOR COBEY: Wasn't there a finding -- wasn't that the basis upon which the State Water Rights Board reduced the request of the City of Fresno for additional water, the fact that they granted the Fresno Irrigation District, as I recall -- what was it, 88,000?

MR. CAROZZA: They granted them some 88,000 acre-feet.

SENATOR COBEY: From the San Joaquin?

MR. CAROZZA: Right, they granted them some 88,000 acre-feet. If you recall, by that court case they granted us an unlimited use of water out of the San Joaquin which we are still fighting. There is no question that the canal system through our city percolates water in the underground. There is no question about this in my mind. They are not lined canals. They are earthen canals throughout.

SENATOR COBEY: Well, the primary source of supply to the underground basin from which you pump are diversions from the Kings River, aren't they?

MR. CAROZZA: The Kings River -- much of it is from the Kings River and much of it is from the San Joaquin also.

SENATOR COBEY: Under Mr. Lee's theory some of it comes from the San Joaquin?

MR. CAROZZA: That is right. We still contend it does.

SENATOR COBEY: But as I recall, the State Water Rights Board did award you 50,000 or 60,000?

MR. CAROZZA: 60,000. We finally settled on 60,000 feet without jeopardy to this case either.

SENATOR COBEY: Has the Federal Bureau of Reclamation made that water available yet?

MR. CAROZZA: Yes, we have a signed contract with them and it will become necessary for us to take the first water from the San Joaquin within the five years and then it is stepped up from that point in increments until we reach 60,000 acre-feet which we have in the contract.

CHAIRMAN TEALE: Thank you very much again. Now, we will hear from Mr. Harvey Banks. We haven't had the pleasure of

having him testify before us for quite a time. Come forward, Harvey.

MR. BANKS: Thank you very much. Mr. Chairman and Members of the Committee, it is a pleasure to appear before you again. My name is Harvey O. Banks, Consulting Engineer. I appear here today representing the Western Municipal Water District of Riverside County. I very much appreciate the indulgence of the committee in permitting me to make this statement on very short notice to the committee. It is very kind of you. I must also apologize that I could not have a written statement. I did not receive my instructions to make this appearance until very late last week and I have not had the time or the opportunity subsequently to prepare a formal statement, so with your indulgence, I would like to make a very brief extemporaneous statement of certain problems involved in reclamation as the district has found them.

The Western Municipal Water District of Riverside County covers that area of Riverside County generally above Prado Dam and lying within the direct drainage area of the Santa Ana River with the exception of the area immediately surrounding Lake Mathews.

The district does not include the area in the over-all Santa Ana drainage that is tributary to Lake Elsinore. Lake Elsinore, I might add, has not spilled into the Santa Ana since 1916. The district water supply comes from three general sources. I should correct that and say the water supply for the lands and property owners within the district comes from three general sources. The first is water exported from the Bunker Hill basin,

exported under long-established rights from wells in that basin, and incidentally, the Bunker Hill basin is the uppermost major ground water basin in the Santa Ana River system.

Then, the district lands and property owners have wells in the basin downstream, the Colton basin, Riverside and Arlington basins, and the district which I represent also imports for the use of particularly the City of Riverside, water from the Colorado River.

The district has had occasion to make rather detailed studies of reclamation from two standpoints, (1) the present waste discharges of the City of San Bernardino and the City of Colton which percolate into the Colton basin and the Riverside basin, have adversely and seriously affected the quality of the water produced from the wells belonging to the lands and property owners within the district and (2) there has been recently a proposal for a large-scale reclamation project within Bunker Hill basin which may threaten the quality of the wells belonging to the exporters which serve lands within the district.

I might say at this point we are not -- I would ask you not to interpret what I'm saying as being opposed to reclamation by the spreading of sewage, properly treated sewage effluent, provided the necessary precautions are taken to protect ground water quality of the ground water basins involved and to prevent the possibility of damage to others. However, in the detailed study we have given to this matter we have reached certain conclusions which may be of interest and help to you in your consideration of this important problem.

It seems to me there are three ways in which

reclaimed water or water reclaimed from sewage and industrial wastes can be put to beneficial use. One, of course, is direct irrigation either for agricultural crops or for such purposes as parks and golf courses. And to give you an illustration of such use outside the State of California, may I say that in the Las Vegas Valley in Nevada, the sewage treatment plant effluents are being very successfully used both for the irrigation of certain agricultural crops and for golf courses.

The second use is for gross industrial purposes such as cooling water. This is also being successfully used in specific plants, but again were it to be put to general use for such purposes, it would require a separate distribution system which would add to the cost.

And finally, there is the method of putting it to beneficial use through mixing it with other waters of higher quality, such as either surface water or ground water.

The remainder of my remarks will deal with the mixing of treated waste waters with ground water through the mechanism of surface spreading, not through injection, since that is not the problem with which my district has been concerned.

I would like to touch on three things, (1) the increasing significance of water quality; (2) the increasing complexity of sewage and industrial wastes, progressive deterioration of the quality and what this means with respect to reclamation and (3) the problems involved in this method of ground water mixing through surface spreading.

I think the increasing significance of water quality and the increasingly strict criteria and standards that are

being promulgated for water quality are probably very well brought out in the 1961 drinking water standards which have been recommended by the United States Public Health Service, in which the limits on certain constituents such as lead have been lowered, that is, for a higher quality, and other constituents have been brought into the drinking water standards for the first time, such as detergents, cadmium and the like. That is, mandatory limits have been set on certain constituents which were not previously considered to be significant. As far as irrigation is concerned, I would like to read an excerpt from a statement by Dr. Frank Eaton, Research Chemist at the University of California, Riverside, based upon the many years of research in agriculture and the relation of quality thereto, conducted at that University, and I quote:

"Any further increments of sodium, bicarbonate, sulphate, and chloride in the waters used to irrigate crops in the Riverside and Corona areas will have adverse effects upon the growth and production of these crops. The more any of these salts is increased, the greater will be the adverse effect. Crop production will decline with any such increases, unless the grower goes to the additional expense of trying to remove the excess salts from the soil solution. This process is commonly known as leaching, but leaching is not always possible. Leaching not only requires additional water and management, but it can be effective only where the soil is of sufficient permeability to make leaching possible, and where drainage conditions permit the salts to be moved completely out of the root zone. Many of the soil conditions in the Riverside area, for example,

where citrus is now being irrigated with water from the Gage Canal, do not permit such effective leaching."

Now, with respect to waste water quality, I think there is no question in anybody's mind but what with increasing industrialization the waste waters are deteriorating in quality. This can be shown by analysis. If the committee is interested, I have them. And the quality of the waste water is becoming increasingly complex. This will go on with advancing technology and increasing industrialization. This is of moment because sewage treatment or waste water treatment will not remove some of these deleterious substances, that is, within the economic limits of possible treatment, nor will the passage through the soil completely remove them and in some cases will have no effect. So that the only way this waste water can be made usable is through the mixture with other higher quality waters to a degree sufficiently to bring the resultant mixture within the acceptable limite.

Furthermore, there are a number of unknowns, unknown substances, or unfamiliar substances perhaps is a better way of putting it, in sewage and waste waters now. This is the reason the Public Health Service has included in their drinking water standards the carbon chloroform extract standards to take care of some of these, what they term "exotic chemicals." This further means that to be successful, in many cases it will be necessary to segregate and separate the more noxious industrial wastes and certain of the domestic wastes for separate disposal to areas where they can cause no trouble if reclamation is to be successfully prosecuted.

Furthermore, I think the experience and the policy of Los Angeles County is excellent where they regard reclamation as an objective in itself as distinguished from sewage and waste disposal. By designing and operating waste reclamation plants for that specific purpose, the likelihood of producing an acceptable quality of effluent is much greater.

Now, as far as ground water basins are concerned and the use of those for the mixture of treated wastes, reclaimed water, in order to bring those within acceptable quality limits, there frequently is an assumption made that the entire capacity of a ground water basin is available for a mixture with reclaimed water. This would be true if we were spreading reclaimed water over the entire basin, but where we are dealing with rather small areas for spreading, we cannot assume in any ground water basin that I know of that the entire volume is available for mixing. Experience has aptly demonstrated and research and experiment have amply demonstrated that there frequently is very little lateral or vertical dispersion of waste water or reclaimed water introduced from the surface into the ground water body. This tends to flow down slopes in rather relatively well-defined narrow patterns with very limited vertical mixing.

If the committee is interested, there is a very excellent article here on a case of cadmium pollution in the East which illustrates that very well.

This means, then, that this resulting mixture will affect or may affect certain wells and certain aquifers or even certain portions of specific aquifers far more than it will others, and this fact must be taken into account in using

ground water for mixing.

Of course, that all leads to the total problem of the salt balance in the ground water basin. And the salt balance in the chain of ground water basins and the ground water basin concerned is in most instances one of a series of basins, in which the outflow from the upper basin flows into the lower and so on down.

Furthermore, we must also remember that it is very well established that the introduction of deleterious substances or pollutants into a ground water basin will have a long-range effect and takes years to correct if damage is done, and I would refer the committee, if they wish, to a statement in the United States Geological Survey Water Supply Paper 1591-A in that regard. I'm sure I don't need to impress on this committee or belabor the importance of our ground water resources and our ground water basins and what they mean, not only for the conservation of local waters, local runoffs, but also for the storage of supplemental water.

In order to prevent this damage, the possibility of damage, permit me to say I think it is imperative that any waste discharge requirements set on a waste disposal or a reclamation operation be set on the effluent of the treatment plant itself rather than on the receiving waters. This has been the case in the proposed reclamation plant at Whittier Narrows and I think, in my opinion, is the proper way of approaching the problem.

Now, finally, as part of this I would like to summarize some of the remaining unknowns in this whole field and

in that case I would like to quote from an article by Professor McGauhey of the University of California, who probably has done as much or more research in the over-all field of waste water reclamation than any other individual, and I quote from his article:

"From analyses of the waste and ground waters involved, together with a knowledge of the character or characteristics of the soil or sand stratum to receive the waste, we thought for some time that a ground water recharge project for the purpose of waste water reclamation could be engineered. Now, we are not so sure. Some new unknown factors have developed.

"Most important among these new unknowns is: the behavior of detergents underground; the possibility that the virus of infectious hepatitis or poliomyelitis may travel with ground waters; the significance in ground waters of insecticides, herbicides, and several other exotic organic compounds for which no satisfactory test has been developed."

I think the state of the art, and it still is an art, has been well summarized in that statement by Professor McGauhey and I would close with the recommendation that the committee consider doing what the Legislature can to expedite research in this field so that reclamation can proceed successfully without damage to the other water resources of the State and without damage to ground water or surface water users.

Thank you very much.

SENATOR CHRISTENSEN: Any questions by the committee of Mr. Banks?

SENATOR COBEY: Mr. Banks, as you know in the San

Joaquin Valley our chief problem currently with industrial waste is cannery wastes. Do you have any information that you can give us as to the reclamation of cannery waste in terms of getting usable water out of it?

MR. BANKS: Well, by and large it seems to me from what I remember of this problem, and permit me to say parenthetically I haven't had much contact with it in about three or four years, to a considerable extent this is a matter of providing the treatment to take care of these very large but relatively short-lived loads in order to reduce the organic content. I believe there are certain salts problems involved here, too, but the principal problem is one of removing the organic materials so that the resultant water will be in such condition that it can be discharged into the available surface waters such as some lower reaches of the San Joaquin, shall we say.

SENATOR COBEY: So it is basically a cost problem in terms of the cost of stabilizing this water?

MR. BANKS: I think that is essentially the largest problem involved.

SENATOR COBEY: There is nothing that can't be removed that will carry over, that might have a bad effect, aside from the detergents?

MR. BANKS: Not that I remember. Now, there may be something in some of the new canning processes. There may be treatment of vegetables prior to canning. There may be some detergents or other compounds which are very difficult to remove, but I must confess I have had little or no contact with that problem for some four or five years.

SENATOR COBEY: Do you suggest in view of the unknowns that are left in the field that there be any greater degree of reclamation than there is now on the question of what can we put back into the ground, I mean what can we put into the ground water basin so far as reclaimed water is concerned?

MR. BANKS: Well, it seems to me that the principal regulation can be achieved through State and regional water pollution control boards with the recognition that in order to exercise the proper control on this the requirements for the discharge under the law should be set on the effort itself rather than upon the receiving ground waters where it may take years, two or three or four years before the effects begin to show up and during which time damage may have been done to a very significant degree.

SENATOR COBEY: In other words, standards as to the composition of the effluent discharged?

MR. BANKS: This is right.

SENATOR COBEY: Now, I suppose that although the prevention of contamination will be the responsibility of the water pollution control board, you would also agree that the State Department of Public Health should -- I mean perhaps actually technically it is pollution and that is the responsibility of the pollution board, and contamination is the responsibility of the State Department of Public Health.

MR. BANKS: There are certain problems in public health involved in some of these waste discharges, which are now for the first time included in public health drinking water standards based upon the possibility of high nitrate water causing cyanosis

in very young infants, fluoride problems, and so on.

SENATOR COBEY: Radioactivity?

MR. BANKS: And that sort of thing.

SENATOR COBEY: And your virus.

MR. BANKS: And the possibility of virus. We don't know on that, but certainly the Department of Public Health has a very definite and active interest in this whole thing as well as the Pollution Control Board.

SENATOR MURDY: Any other questions of the committee? If not, Mr. Banks, we thank you very much for being here. We would like to have you testify any time you wish.

MR. BANKS: Thank you very much for the privilege of testifying on short notice.

SENATOR MURDY: That concludes the hearing.

(Thereupon the hearing was adjourned.)

REPORTER'S CERTIFICATE

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This is to certify that I, Alice Book, a Certified Shorthand Reporter, was present at the time and place the foregoing proceedings were had and taken before the Senate Fact Finding Committee on Water Resources, State of California, held in Sacramento, California, on October 31 and November 1, 1961, and that as such reporter I did take down said proceedings in shorthand writing and that thereafter I caused the shorthand writing to be transcribed into longhand typewriting, and the foregoing pages, beginning at the top of page 1 to and including line 14 on page 167 hereof, constitute a true, complete, accurate and correct transcription of the aforementioned shorthand writing.

Dated this 8th day of November, 1961.

Alice Book

Certified Shorthand Reporter